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Proceedings of a Workshop on the Conservation Status of Atlantic Salmon

Compte rendu d'un atelier sur la conservation du saumon atlantique

13-16 February 2006
Gulf Fisheries Centre
Moncton NB

Les 13 et 16 février 2006
Centre des pêches du Golfe
Moncton (N.-B.)

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March 2007 | **mars 2007**

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FOREWORD

This document is a product from a workshop that was not conducted under the Department of Fisheries Oceans (DFO) Science Advisory Process coordinated by the Canadian Science Advisory Secretariat (CSAS). However, it is being documented in the CSAS Proceeding series as it presents some key scientific information related to the advisory process. It documents contributions first tabled and discussion at a DFO-SARCEP (Species at Risk Committee / *Comité sur les espèces en péril*) sponsored workshop in Moncton (February 2006) to begin the development of a 'Conservation Status Report' (CSR) for Atlantic salmon. When completed in 2007, the CSR could form the basis for a Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status report, recovery potential assessment and recovery strategy, and most importantly, enable DFO to implement pre-emptive management measures prior to engagement in any listing process.

AVANT-PROPOS

Le présent document est issu d'un atelier qui ne faisait pas partie du processus consultatif scientifique du ministère des Pêches et des Océans, coordonné par le Secrétariat canadien de consultation scientifique (SCCS). Cependant, il est intégré à la série des comptes rendus du SCCS car il présente certains renseignements scientifiques clés, liés au processus consultatif. Il documente les nombreuses contributions présentées au départ ainsi que les discussions lors d'un atelier parrainé par le MPO-SARCEP (*Species at Risk Committee* / Comité sur les espèces en péril) à Moncton (février 2006) en vue de commencer l'élaboration d'un rapport sur la situation de la conservation du saumon atlantique. Lorsqu'il sera terminé, en 2007, ce rapport pourrait servir de base à un rapport de situation du Comité sur la situation des espèces en péril au Canada (COSEPAC), à une évaluation du potentiel de rétablissement et à un programme de rétablissement mais, avant tout, il permettra au MPO de mettre en œuvre des mesures de gestion anticipées avant même de s'engager dans un processus d'inscription.

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ABSTRACT

Atlantic salmon scientists, together with several peers and external reviewers, met in Moncton, February 13 -16, 2006, to update information on the distribution, biology, and status of sea-run Atlantic salmon in Canada. The session included presentations and reviews of: population structuring and considerations for the identification of Ecologically Significant or Conservation Units; a new national list of salmon rivers; treatises on biology, life history, stock groupings; population regulation, stock status and trends; habitat, and residence requirements. Other contributions reviewed predators and prey of salmon, landings and catch information, conservation requirements and constraints to population rebuilding.

New information included: the addition of nearly 140 rivers to the frequently referenced 550 salmon rivers in Eastern Canada; an analysis of change in adult abundances over the last 15 years which, depending on choice of method and criteria, suggested that about one-half of 20 Salmon Fishing Areas could be considered candidates for some level of 'recovery'. Data from the most recent years, however, suggested that downward trends in abundance in some Eastern Canadian Atlantic salmon had bottomed and that, with the exception of southern most populations, may actually be increasing. Although survival at sea was viewed as being the single largest common constraint to increasing abundance, density dependent constraints in freshwater may also have the potential to limit recovery in some rivers.

From among the many discussions, workshop participants identified that the delineation of Conservation or Ecologically Significant Units should consider in addition to molecular genetics, biology, life history traits, morphology, geolography and management useable objectives. They as well concurred that published information on molecular genetics of Eastern Canadian populations was by itself inadequate to be of practical value in designating more than one, or possibly two units. The use of and method of calculation and interpretation of 'percentage of conservation requirements', and 'percentage decline' over an agreed upon time frame to ascertain stock status was debated, and the status in terms of total mature individuals was not always consistent with other 'indicators', especially juvenile abundance. For the provision of advice on recovery in the context of the Species at Risk Act, there was general concurrence that status, in terms of the operational standard limit reference point of 2.4 eggs/m^2 or some variant thereof, was inadequate because of habitat variability among rivers within and between Regions, and the absence of criteria for risk assignment. In total, consensus on the analyses and portrayal of status, trajectories, and target(s) for recovery were recognized as challenges requiring further attention.

Species Description, Atlantic Salmon Genetics and Designation of Conservation Units in Eastern Canada (WP 012)

Presenter: P. O'Reilly
Reviewer: I. Fleming
Rapporteur: F. Whoriskey

WP Summary: A number of different methods have been developed for identifying conservation units (CUs). However, there are a surprising number of commonalities in the data needs among most methods. An approach is proposed for identifying Atlantic salmon CUs that uses a suite of these methods. It consists of constructing tables documenting what is known of historic and present adaptive divergence in Atlantic salmon, and using this information to analyze target Atlantic salmon groups. The analysis would then use the data with the suite of the proposed methods, to see if the different methods were consistent in the identification and status of the CUs.

The employment of the suite of different methods is viewed as a strength because it could identify cryptic distinct groups, which might not be evident from any single approach. With regards to developing the process to establish Atlantic salmon CUs, the author proposed the following: "*The objective of the process used to designate Conservation Units in the Conservation Status Report is to rigorously and systematically assess the degree of 'distinctiveness' of all (not just those with different probabilities of extinction) candidate populations of Atlantic salmon in Eastern Canada, where 'distinctiveness' reflects the presence of ancestral lineages, but more importantly, the existence of genetically based adaptive differences.*"

Discussion and Conclusions

Reviewer: This document is a well written and an especially good summary/ overview of the available methods for identifying units for conservation.

- sections 1.1 (Name and classification) and 1.2 (Morphological Description of the species) could be combined and reduced to a paragraph or so as the focus of the document is on intra- rather than inter-specific differences
- might be useful to identify the method(s) you feel are most appropriate for identifying CUs for Atlantic salmon – or the pieces of the different methods you feel would be most appropriate – basically what do you or the group feel are the strengths and weaknesses of the different methods (particular attention to Green 2005) as they apply to Atlantic salmon(?)
- Table 1 (Published strategies for identifying and designating Units of Conservation) is very helpful; Table 2 (Candidate populations of landlocked and anadromous Atlantic salmon) may be better included in Chapter 2 (WP 013, Appendix 4), where a compilation of salmon rivers would appear
- Table 3 (Data checklist and form to tabulate criteria score for CU designation) is helpful in providing a start to assembling key criteria – it will allow a hierarchical description of Atlantic salmon units from the individual population/river to ecological/life history categorization and ultimately major lineages based on molecular genetic data
- this strict hierarchical categorization based on biology alone then provides a framework upon which to lay the concept of the CU which implicitly, if not explicitly, incorporates human values (i.e., identifying the scale at which to focus conservation concerns/efforts)
- given the importance of Table 3, more space could be taken to explain what would go into it. For example, it is confusing to have both characteristics and methods for defining CUs listed in the same column on the left side. Moreover, there is a large number of items listed under the left column – can they be grouped? – life history, geological/physical habitat, ecosystem

characteristics, genetics, etc. Need to ensure that the table is not overwhelming to the reader
- identify knowledge gaps
- clarify that the major differences in genetic characterization reflect/ are a result of relatively long-term isolation
- clarify that this is but one layer identifying CUs; layers for ecological and life history patterns etc., will provide further refinement
- clarifies the current status of genetic structuring for Canadian Atlantic salmon
- identifies strengths and weaknesses of the current data – provides some insight about the major remaining knowledge gaps
- consider moving section on population structuring ahead of the discussion on CUs, thus providing a good lead-in

Working Group: Much discussion ensued about the objectives for the use of the CUs. It was recognized that there could be a 'disconnect' between the geographic scale of the CU (e.g., potentially at a regional level) and the management unit (possibly a river or a tributary-specific population), which might or might not impact existing management regimes. Currently, only molecular genetic data from allozymes are available for addressing CUs in NFLD, Labrador, Quebec, Nova Scotia, and New Brunswick. Data from several classes of molecular genetic markers were used only in addressing CUs in Bay of Fundy/ Southern Uplands populations, though this is being addressed and will change within the year. These data and biological measurements support the existence of "distinct" Atlantic salmon groups in Labrador (and probably those from the Ungava Peninsula are distinct from Labrador), Newfoundland, the Southern Upland of Nova Scotia and the inner Bay of Fundy. Oddly, Gulf of St. Lawrence and Québec region populations cluster with outer Bay of Fundy salmon, although they are believed to be reproductively isolated from each other.

DFO Pacific Region's Wild Pacific Salmon Conservation Policy is borne on a CU approach. Jim Irvine briefed the group on the West Coast experience. The definition of CUs and identification of their objectives was and is a time-consuming and difficult process for the five different species of Pacific salmon. West Coast salmon CUs are not management units in the traditional sense. However, they are biologically and scientifically based. As presently defined, they are aligned with Green's (2005) COSEWIC minimum designatable unit approach: units with common status trajectories and threats will remain separate. Irvine strongly encouraged the workshop to include the Pacific approach as one of the methods used for Atlantic salmon.

The group noted that there are still sampling and analytical problems in the data that have been presented e.g., the need to adjust F_{ST} statistics (a measure of the variation between two Subpopulations relative to the variation in the Total population) for kin groups in small populations. For this reason it seems premature to come forward with the "definitive method" this early in the process.

References

Green, D.M. 2005. Designatable Units for status assessment of endangered species. Conserv. Biol. 19 (6):1813–1820.

Distribution of Sea-Run Atlantic Salmon in Eastern Canada (WP 013)

Presenter: F. Caron
Reviewer: I. Fleming
Rapporteur: L. Marshall

WP Summary: The paper reviewed the known distribution of Atlantic salmon indicating that the known limit of anadromy in the St. Lawrence River was the Rivière Jacques-Cartier near Quebec City. The few populations in Hudson Bay rivers do not migrate beyond their estuaries; only four of the many rivers in Ungava that contain salmon support populations that migrate to West Greenland. The northern distribution in Labrador in terms of contiguous populations is approximately Davis Inlet. Included in the presentation were the estimated numbers of rivers in Atlantic Canada and Quebec, i.e., 689 (revised Oct 06) summed by the author from recently contributed regional information. This compares with 622+ rivers (Anon. 1978) and 404+ rivers in O'Connell et al. 1997, 655 in the web-based NASCO database http://www.nasco.int/asd/index.asp and 550 reported by the International Council for the Exploitation of the Seas.

Discussion and Conclusions

Reviewer:

- reduce the section on global range to a single paragraph and focus on the NA range
- establish a numbered list (table) of salmon rivers and their location containing information on whether or not their populations are (1) self-sustaining, (2) extinct and (3) sporadically present (intermittent) populations – moreover, (a) anadromous and (b) resident (non-anadromous) populations
- provide a map(s) of the locations of the rivers, if possible
- identify strengths and weaknesses of the information (e.g., Labrador has been poorly surveyed) – i.e. identify the knowledge gaps
- provide more detail on the northern limit (e.g., Ungava Bay, Hudson Bay and Labrador coast)
- discuss trends in distributional range (also refer to worldwide patterns – e.g. contraction on the southern range, including Maine - there is some issue of how long Atlantic salmon have been in New England – was there an expansion southwards with the mini-ice age in the 1500s; see the National Academy of Sciences report on "Atlantic salmon in Maine") – ranges expand and contract naturally with climate – is there any evidence of expansion northwards (compare with patterns of Atlantic salmon in Russia and of Pacific salmon in North America)?

Working Group: General discussion included: the concern that the NASCO data base (Access) was accessible only for viewing, that it resides outside Canada, that "Habitat Management" alone had been responsible for its assemblage, and the realization that additional qualitative inclusions about each river (in columns; headers to be decided) had potential to transform a 'list" into a living document capable of providing insight into causes for range contraction extension and subsequent/ potential loss of genetic variation. Such a list could document gaps in knowledge, extirpations, possible constraints to persistence, Aboriginal Traditional Knowledge, etc. The list would benefit from inclusion of a Geographic Information System (GIS) compatible structure, and inclusion of information on 'landlocked' populations (including Ontario?). Some concern was expressed but largely dismissed that a new 'number' of salmon rivers would compromise an existing list developed by the Atlantic Salmon Federation.

A Subgroup (initially Caron, Reddin, Amiro and O'Reilly) was struck that during the course of the workshop, was to consider available information (including NASCO database) and propose the framework and headers for a list that could be populated by Science personnel and reside in Canada. Their recommendations included:

- each region to build on the Excel file of sea run rivers provided by F. Caron for the workshop
- river status to be assigned only to those entities that flow directly into the sea or estuary below the high tide mark
- a column to provide latitude and longitude
- a column to provide comments/ reference, especially for historic status.

References

Anon. 1986. Atlantic salmon management zone profiles - Compendium to: Strategies for the Long-Term Management of Atlantic Salmon. Report of the Special Federal/Provincial Atlantic Salmon Working Group. 166p.

O'Connell, M.F., D.G. Reddin, P.G. Amiro, F. Caron, T.L. Marshall, G. Chaput, C.C. Mullins, A. Locke, S.F. O'Neil, and D.K. Cairns. 1997. Estimates of conservation spawner requirements for Atlantic salmon (Salmo salar L.) for Canada. CSAS Res. Doc. 1997/100 58p.

Stock Status Summary for Atlantic Salmon from the Gulf Region, SFAs 15-18 (WP 023)

Presenter: G. Chaput
Reviewer: M. Bradford
Rapporteur D.G. Reddin

WP Summary: This paper provides a summary of the status of salmon stocks in the Gulf Region encompassing Salmon Fishing Areas (SFAs) 15 to 18. It includes those rivers flowing into the southern portion of the Gulf of St. Lawrence. Salmon are harvested by two user groups: Aboriginal people and recreational fishers. Aboriginal people fish for salmon under specific agreements for food, social, and ceremonial purposes depending on their needs. Recreational fishers are allowed to retain small salmon less than 63cm but must release large salmon that are equal to or greater then 63 cm. All commercial fisheries have remained closed since 1984. The data used for assessment purposes comes from juvenile surveys, smolt monitoring, and adult monitoring projects.

Across all areas of the Gulf, small and large salmon abundance was higher in the late 1980s and early 1990s than in recent years. In PEI, salmon are stocked in up to six of PEI's larger rivers by release of smolts that have been reared semi-naturally in open impoundments. This program has been most successful on the Morel River. Angling catch in 2005, which is taken as an index of abundance, declined 53% relative to the previous five-year mean whereas large salmon catches decreased by 42% relative to the previous five-year mean. Conservation requirements are determined for Gulf rivers based on 2.4 eggs per m^2 of parr habitat and 1.68 eggs per m^2 for the Restigouche River which borders the Province of Quebec. For the Restigouche River, conservation requirements were likely met annually between 2000 and 2005. The status of the Nepisiguit River is uncertain. For the Miramichi River, conservation requirements were not met in 2005 and have been met only four times in the last 10 years. Conservation has been met on the Margaree River every year since 1985.

Sea survival is impacting on returns to Gulf salmon rivers similarly to other rivers in Eastern Canada whereby returns per unit smolt output have been low in recent years. A number of

constraints on abundance including fisheries, environmental, diseases, land use and density dependence in freshwater have been identified.

Discussion and Conclusions

Reviewer: The paper is well written and straight forward. I had some confusion about the use of the term "conservation" as a noun, but have come to learn this is local shortcut for "conservation requirement".

- the paper alludes to the presence of a number of rivers in the Gulf Region, but only three are assessed. It may be useful to provide an indication of the number of other rivers in the Region, their potential contribution, and any information on the status of populations within them
- some of the more interesting analyses of these data are found in Chaput and Jones 'Replacement ratios and rebuilding potential (p 21).

Working Group: A general discussion ensued on the definition of conservation and juvenile surveys as an index of abundance. With respect to stock-recruit issues and abundance plots it was thought useful to have bivariate plots and as well, look for cycling with environmental variables. There was some thought that we tend to focus too much on the previous year for comparisons with the current year, and do not place enough emphasis on the more important long-term declines. There should perhaps be more effort put toward the Pre Fishery Abundance (PFA) type run reconstructions that permit the detection of population structure over the last 35 years, and there should be greater effort in explaining the cause of declines or increases.

<u>Stock Status: Newfoundland and Labrador Region (WP 028)</u>

Presenter: J.B. Dempson
Reviewer: I. Fleming
Rapporteur: J. Gibson

WP Summary: The purpose of the document is to provide an overview of the status of Atlantic salmon in the Newfoundland and Labrador Region by summarizing information provided in several recent documents. A tremendous amount is known about salmon in Newfoundland and Labrador, but there are still many knowledge gaps. There are 20 to 25 rivers that are assessed, and assessments are all done using counts of one sort or another using a single stage in the life cycle. Angling information is not typically used. A composite index has been developed to summarize status by geographic area. Population status is variable. Some populations are declining but are still above the conservation requirement, whereas some other populations are increasing. Others are low relative to the conservation requirement.

Discussion and Conclusions

Reviewer: This document is well written and provides a good summary of stock status in NL and limitations of the available data

- it addresses stock status, but it might be useful to place this section more within the context of conservation units thereby integrating it with the overall objectives of the CSR
- it would be beneficial to see a presentation of knowledge regarding groupings of populations that may exist in Newfoundland and Labrador – e.g. based on life history, migration, etc. – are there unique populations or groups of populations?
- define "licence stub system" or provide a glossary

- either provide a more complete explanation of the 'composite index' or more basic explanation highlighting, in a general way, what it captures and refer the reader to a citation for more details should they need it
- are there correlations among annual abundance numbers among the different populations and at what spatial scale. This might also involve comparing these with populations from the Gulf Region and/or other regions (this may be part of another section however). Are there general patterns?
- what are the knowledge gaps?

Working Group: Trends in populations within a geographic area appear to vary widely. Are the geographic areas used to present data appropriate? Are there alternatives? One option might be to look at the regional scale of correlation in population size. The authors responded that this kind of analysis had been done at the Sydney workshop and might be worth considering. However, within areas, human effects differed, for example, on Conne River, declines are disproportionate to the other rivers. Not all effects are regional. Besides trends, there may also be ecological or biological reasons to identify different areas. Discussion focused around the nature of the populations and the reasons for the patterns that were presented. The Newfoundland fishery was with one exception based on "small" salmon. There was potentially a slight increase in "large" salmon after the moratorium, but increased survival may have occurred without changing the small to large salmon ratio because of slower growth relative to some southern populations (not all repeats are large). More fish are not being seen as a result of moratorium, and the number of smolts do not seem to be increasing as a result of increased egg deposition.

Constraints on abundance are not well known. Aquaculture is a potential constraint in some areas but escapes are not routinely seen in rivers. Populations don't seem to produce more smolts as egg depositions increase, suggesting early rearing capacity in fluvial habitat is a potential constraint. It does not seem to be an effect of the counting facilities (fences) as similar patterns are seen elsewhere using camera counts and dive counts. Fish passage was added on several rivers and in some places abundance increased (Torrent River), but not everywhere. The warm intermediate layer in the ocean, which was once proposed as an influence on salmon abundance, has reverted to near average levels without commensurate changes in abundance.

A question was raised about the inclusion of the index of small and large salmon in Labrador in the report; the consensus was to include it. A point of clarification was raised on the 'composite index' and whether each river was weighted - the average is in fact a geometric mean, which reduces the influence of large rivers on the index.

Discussion ensued about the biological characteristics (age distribution, etc.) of the populations. There are about six to 10 rivers with good biological data, including ages, length, weight and sex ratio. Data on large salmon is limited due to their scarcity. Biological sampling has only ever occurred at research traps; none are available from indirect abundance estimates or recreational fisheries. Egg viability of large (mostly repeat) salmon is an unknown, but may not be an issue in Newfoundland and Labrador where 80% of eggs come from maiden 1SW fish.

Life History Characteristics of Atlantic Salmon (WPs 014 and 015)

Presenters: M.F. O'Connell and G. Chaput
Reviewer: J. Irvine
Rapporteur: D. Cairns

WP Summary: Geographic variation in smolt age and size, sex, and age distribution of returning adults is examined for eastern Canada. Several features show a south-north trend, notably the tendency for smolt age to be greater, and the proportion of two-sea-winter returns to be less, in northern areas. Principal component analysis shows geographic clustering in biological characteristics. Populations in the Maritimes and eastern Quebec tend to cluster together, as do populations in Newfoundland and Labrador.

The presenters highlighted that they re-examined earlier mapped groupings of biological characteristics by looking at age-at-maturity, variation in smolt age and survival at various stages within and between rivers and, as well, differences in biology between fluvial and lacustrine rearing areas, and relative prevalence of male precocity etc. They provided as thorough a list as possible of literature sources, and assembled a spreadsheet with biological characteristics by river including smolt age distributions (104 rivers), proportion of returns by size, proportion of females by size, mean fork length by group etc., and examined which characteristics might be environmental and which might be adaptive (infers genetics), e.g. greater smolt age in northern areas is likely a temperature effect; proportion of females and proportion of sea ages is likely adaptive to local environment.

The authors also showed that plots of smolt age vs. north-south position confirm higher smolt age further north. In southern areas, there is a greater mix of sea ages at return while in the north there is a high proportion of small salmon among returns; that most large salmon in Newfoundland are repeat spawners, elsewhere (St. Georges Bay and Labrador) large salmon are mostly maiden fish. In general, southern populations of small salmon have a greater mean size than small salmon in northern populations, and that principal components analysis was effective in reducing a data set, e.g., characteristics of small salmon (104 rivers) such that 81% of variance explained by three components showing clustering by geographical region. Large salmon of Maritimes and Quebec clustered while those of Labrador were very different.

Discussion and Conclusions

Reviewer: These contributions constitute a well-written thorough synopsis of the life history of Canadian Atlantic salmon.

- a brief statement giving the purpose of the chapter would be useful
- the authors might make use of summary tables or Appendices as they describe many differences among areas, life stages etc. in the text, and it might be appropriate to summarise some of these differences in tabular form
- the chapter is on Canadian Atlantic salmon but I was somewhat surprised how few references to American and European studies were provided; similarly, there are some instances when comparisons with other "salmon" might be worthwhile
- p 4 - non-anadromous or land-locked - the latter term is misleading since some of these populations are not land-locked
- p 6 – discussion on use of lakes - I found the statements that non-fluvial habitats are marginal or secondary surprising as growth of parr in lakes was higher than in streams and smolt size in lacustrine dominated systems was highest (p 9) - the situation is similar on the Pacific coast for coho salmon where juveniles occupy streams and lakes and we usually describe coho as opportunistic, occupying a wide range of habitat types

- p 7 – freshwater maturation; is there any evidence for a genetic basis for male residualism among anadromous Atlantics as seems to occur for masu salmon (Oncorhynchus masou)?
- it would be interesting to see more speculation on reasons for some of the temporal patterns documented, e.g. how widespread are patterns of increasing size (p 16) and what non-fishery reasons for size increases might there be?; similarly, can one speculate on mechanisms for increasing proportions of females (p 17) as this seems particularly relevant given all the ecosystem changes in the North Atlantic
- the life history of Atlantic salmon can be complex as illustrated in Fig. 1. - it seems it would be relatively easy to develop life history models - has this been done?

Working Group: Chaput noted there is some tendency for salmon to have larger mean sizes as populations decline i.e., in spite of increased mortality it would not appear that competition for food is an issue. O'Connell noted that increases in size in Newfoundland may be at least in part due to closure of fisheries. Run timing was not, but should be included in the quantitative analysis; however trends are described qualitatively.

Summary Discussion Re: Conservation Units

Rapporteur: L. Marshall

Discussion ensued following O'Reilly's presentation especially "an approach to identifying CUs - a beginning and the summary table of approaches". The approach of Green (2005), which guides COSEWIC decisions and (Crandall et al. 2000) which identifies management units, appeared to offer the best of all proposals. Clarity was sought on what it was that was actually in need of conserving, i.e., what was the objective and at what scale is one prepared to preserve same. The more fundamental questions were asked re: how much loss can be endured before a population with unique characteristics cannot be restored and what amount of knowledge is required to identify what is perceived to be an important 'save'. There was consensus through the discussion that COSEWIC and management usable objectives should guide the choice of a method. One proposal was to populate Table 3 of WP 012 with two or three examples so as to indicate what data inputs would be necessary to satisfy the requirements.

Discussion continued following Caron's summary Atlantic salmon distribution paper (WP 013) and O'Reilly's population structuring (WP 012), with assistance from J. Irvine who related the Pacific salmon strategy of partially adopting Green (2005)(COSEWIC) while at the same time allowing that the CUs will have to be managed i.e., overlap between COSEWIC and DFO Species at Risk (& Policy) objectives. There was the further suggestion that alignment with the approach e.g., outlined in "Canada's Policy for Conservation of Wild Pacific Salmon" could be beneficial i.e., the Units should be genetically and geographically distinct and that the time of replacement/ recovery through natural straying should be limited to a human life time (100yrs). The west coast variables (unpublished, to be examined by O'Reilly) include taxonomy, genetic lineages, geolography (geology and geography), ecological zones, water temperatures, life history, and molecular genetics i.e., a layered approach objectively determined through a structured scientific (only) process.

In response to the question: why bother with this process when DFO doesn't appear to want to know that stocks are being extirpated (?), it was proposed that at least fishery managers would have a new level of awareness. There was also the suggestion that the number of CUs would lie somewhere between the six interpreted units of Verspoor and every river.

Discussion then returned to the definition of 'Conservation' and 'Objectives' and 'Purpose'. It was suggested that the draft 'Wild Atlantic Salmon Conservation Policy' offered a suitable definition of 'conservation', i.e., *The protection, maintenance, and rehabilitation of genetic diversity, species, and ecosystems to sustain biodiversity and the continuance of evolutionary and natural production processes',* that a Conservation Unit would be a '*group of wild salmon sufficiently isolated from other groups that if extirpated is very unlikely to re-colonize within an acceptable time frame*' and that the objective of the *'Unit'* is to *'safeguard the genetic diversity of wild Atlantic salmon'.* Alternate proposals for the definition of conservation were: 1) sustainable use that safeguards ecological processes and genetic diversity for present and future generations, and 2) the planned management of human activities that might affect fish habitats to prevent destruction and subsequent loss of fisheries benefits. (*Policy for the Management of Fish Habitat*; The DFO Lexicon, 1993). No conclusions were reached by the Working Group although the discussion served to suggest a narrow choice of options to fit COSEWIC and DFO SARCEP (Policy/ Management) objectives and that may be through the draft approach being developed by Pacific Region.

References

Crandall, K.A., O.R.P Bininda-Emonds, G.M. Mace, and R.K. Wayne. 2000. Considering evolutionary processes in conservation biology. Trends in Ecology and Evolution 15: 290-295.

Green, D.M. 2005. Designatable Units for status assessment of endangered species. Conserv. Biol. 19 (6):1813–1820.

Stock Status of Atlantic Salmon in Quebec (WP 022)

Presenter: F. Caron
Reviewer: J. Irvine
Rapporteur G. Veinott

WP Summary: The paper provided a comprehens..e update of 22 years of large adult returns including local commercial fisheries, by four groupings (rivers where hatchery smolt account for over 10% of the returns in the last 10 years; small stocks with less than 500 salmon; medium size stocks with 500 to 1,000 salmon and large stocks with over 1,000 salmon). In general the hatchery supported rivers showed increases in returns of large and small salmon; small and medium stocks showed a decline or no trend and large stocks, with one exception, showed a decline or no trend - overall, returns of large salmon are down. For spawners the trend was less pronounced than that of returns, reflecting the increased conservation measures applied to fisheries. However In the last five years, the majority of monitored rivers didn't reach their conservation limit.

Also provided were estimates of freshwater production and marine survival. In the case of marine survival the long-term downward trend since the 1991 cohort seems to have stabilized on one river and possibly reversed in another.

The author also examined biological characteristics of Quebec salmon as well as trends in adult abundance. Smolt ages increased from <2.5 years in the west to 4+years in the east and north (Q9 and Ungava). Mention was also made of an ongoing study (Ph.D student) to genetically describe 758 river populations in Quebec.

Discussion and Conclusions

Reviewer: I compliment the author for pulling together a huge amount of data. The chapter is apparently not complete (status summary missing) so my comments are general and largely in search of additional information, e.g.,

- a map showing the seven salmon zones
- technique for estimating subsistence catches when reports were not available (p 1, last paragraph)
- discussion of mechanisms for major temporal patterns; e.g. Fig 7.2.2.-4Q (In-river returns of small returns) show reasonably consistent declines in returns
- the role of enhancement in the increased returns in Fig 7.2.1.Q (In-river returns for Québec's rivers with restocking accounting for more than 10% of the returns).
- an explanation or theory for patterns in freshwater and marine survival (Fig. 7.5.3.Q [Freshwater from egg to smolt]+ 7.6.1.Q [Total smolt sea survival])?
- explain symbols for Figs 7.2.5 [Global evaluation of the number of return salmon for Quebec, 1984-2004] +7.3.1 [Global evaluation de number of spawner salmon for the Québec, 1984-2004]; male and females with 95% CLs?
- meaning of last sentence of 7.4 on p 4, i.e., 'When we exclude these rivers, a slight majority of other rivers had reach(ed) conservation level on a regular basis'?
- an indication of years in which data were not gathered e.g., Table 7.2.1.Q,[In-river returns for Québec's river with restocking accounting for more than 10%] Du Grand Pabos Quest, 1990 and 2001
- the possibility of categorising biological status within red, amber and green zones relative to lower and upper bench marks for conservation requirements as is indicated in the 'Wild Pacific Salmon Conservation Policy'

Working Group: It was suggested that there could have been a statement on the status of the stocks, perhaps speculation about the cause of the decline, and more details on stocking/ restoration efforts. It was also noted that sea survival was down after closure of the commercial fishery but that no explanation was postulated.

Application of COSEWIC Decline Criteria to Eastern Canadian Salmon (WP 026)

Presenter:	J. Gibson
Reviewer:	M. Bradford
Rapporteur	J.B. Dempson

WP Summary: Returns to monitored rivers of Atlantic Canada and Quebec were examined as a percentage of the conservation requirements by Salmon Fishing Area, as a percentage change in five-year mean population size and as percent declines in salmon populations over 15 years (three generations) against the 70% ("endangered"), 50% ("threatened") and 30% decline criteria of COSEWIC.

An analysis for the 2001 - 2005 time period against conservation requirements indicate that large and small salmon New Brunswick Bay of Fundy populations (SFAs 22-23) as well as Nova Scotia Mainland populations (SFAs 20-21) were, on average, less than 25% of their conservation requirement. In Atlantic coast Cape Breton rivers (SFA 19), returns for all but the small salmon component on North River averaged less than their conservation requirement. Returns for populations along the Gulf shore (SFAs15-18) typically exceeded their requirements for small salmon, but were less than the requirements for large salmon. For the most part, large salmon returns to Quebec rivers were below their conservation requirements, with most rivers in Q6 and Q10 averaging less than 50% of the requirement. In Newfoundland (SFAs 9-14), on

average, returns for some populations were near or above their conservation requirement (SFA 14, SFA 11, and SFA 9) with the exception of SFA 5, where returns were in the range of 35% to 150% of their requirements. Populations in SFA 4 were variable.

Three-generation change in population size for salmon populations indicate that 11 of 17 assessed populations in the Maritime Provinces meet the decline criteria for "endangered" and all populations show declines. Patterns in Quebec vary with the small and large component. Assuming the cause of the declines is unknown, in Quebec, based on the large component, 11 of 13 populations north of Godbout meet the decline criteria for "endangered", whereas 6 of 13 meet the decline criteria for "endangered" based on the small component. Of 20 populations to the south, based on the large component, two populations meet the decline criteria for "endangered" and four meet the decline criteria for "threatened". Based on the small component, none of these populations meet the decline criteria for either "endangered" or "threatened". Of 15 populations in Newfoundland, assuming the cause of declines is unknown, two populations meet the decline criteria for endangered based on the large component and one population meets the decline criteria based on the small component. Based on the small component, three other populations show a decline of less than 30%, whereas all others show an increase.

Discussion and Conclusions

Reviewer: The use of "COSEWIC" in the title implies that their procedures are strictly adhered to, and it might be easier to recast the work as "an analysis of recent declines in salmon" the presentation of the coast-wide results in the figures will be a very useful discussion aid for managers and policy people and the public.

- the use of the slope of ln(N) on time regression (with the associated SE) is a more commonly used metric (at least on the West Coast) - if the data do not display a consistent trend the SE will be correspondingly large
- a problem with calling this "COSEWIC" is that the level of aggregation here is individual streams, and it's not clear whether that represents DU's, populations or another level of aggregation - a COSEWIC assessment begins with the delineation of DU's, and then status - at the minimum it should be noted that you have considered each stream as a 'population'
- does the separation of the trends of large and small sized fish add to the overall conclusions as opposed to the total number of spawners?
- "small (salmon) requirements" on p 2 is local lexicon?

Working Group: There was concern that, in the absence of adjustments for exploitation prior to the closure of the commercial fishery, the percentage change (decline) in populations may have been under estimated, and that declines of 2-3% per year could not be identified through COSEWIC criteria. There was as well concern expressed re: approach to the analyses, i.e., treat each stream separately and then summarize or combine stream information for a designated unit and then do the analyses, and as well, a possibility of the confounding problem when considering pre-moratorium versus moratorium periods especially where meeting conservation does not provide the surpluses available

It was noted that Pacific Region addresses the COSEWIC guidelines by use of a regression slope to identify declines over time and that the five-year running mean used here-in is less influenced by the start and end points(?). It was also suggested that one might separate 'large' from 'small' rivers to see if there is a difference in how stock abundance is changing.

Summary Discussion: Stock Status

Rapporteur: L. Marshall

Following presentations on the status of stocks in Newfoundland and Labrador, Quebec and overview analyses of Atlantic Canada, there was a short discussion on alternate approachs to regional and overview analyses. Suggestions ranged from the use of alternate "rates" of change, i.e., averaged between each year as opposed to between five-year periods and, the use of regression analyses for derivation of means and confidence intervals to cluster analyses championed by E. Prévost. It was also felt that the "master" data file for all regions would benefit from "cautionary notes" to guide the selection of 'like' data and impacts on the data of management actions and that there should be an agreed-upon methodology for doing such an assessment. There was as well some dissention in using conservation requirements as a point against which to measure status (inappropriate for COSEWIC but appropriate for stakeholders).

It was felt by the workshop participants that no new efforts could be considered in the time available. Gibson, Chaput and Caron subsequently engaged in a short discussion with the objective of insuring that appropriate data and adjustments in analyses were incorporated in the Gibson analyses.

Stock Status of Atlantic Salmon in the Maritimes Region (WPs 024 and 025)

Presenter: P. Amiro and R.A. Jones
Reviewer: M. Bradford
Rapporteur D. Meerburg/ L. Marshall

WP Summary: The status of stocks in the Maritimes Region were presented as four separate files: Eastern and Southern shores NS, Eastern Cape Breton, Inner Bay of Fundy and Outer Bay of Fundy NB.

Returns and escapements to almost all rivers along the Atlantic Coast of mainland Nova Scotia (SFAs 20 and 21) in 2004 were insufficient to meet conservation requirements. Extirpated populations have doubled in 15 years and now include at least 50% of the 65 Southern Upland rivers. Wild salmon populations are now at critically low abundance and remaining remnant populations require actions to maintain their genetic integrity and ensure their persistence. Adult salmon populations in eastern Cape Breton (SFA 19) were assessed on the Middle, Baddeck and North rivers. Conservation requirements which have generally not been achieved for these populations in recent years were as well generally not met in 2004. Salmon populations of the inner Bay of Fundy are designated as 'endangered' and listed under SARA. Salmon populations of the outer Bay of Fundy (western part of SFA 23) did not attain conservation requirements in 2005. Where adult salmon were monitored, egg depositions were less than 20% of requirement. The monitored populations of outer Bay of Fundy rivers west of the Saint John River system have also declined precipitously and some are extirpated or nearly so. Efforts there have also been initiated to preserve the remaining genetic diversity for potential recovery. Few biological characteristics were presented and none analyzed.

Discussion and Conclusions

Reviewer: These reports were somewhat incomplete, and would benefit from an editorial revision.

- the references were missing and figure captions and labeling were absent in some cases

RÉSUMÉ

Les scientifiques spécialistes du saumon atlantique se sont réunis en compagnie de plusieurs de leurs pairs et d'examinateurs externes du 13 au 16 février 2006 à Moncton afin de faire le point sur la répartition, la biologie et l'état du saumon atlantique anadrome au Canada. À cette occasion, on a présenté des exposés et des examens de la structure de population ainsi que des facteurs à prendre en considération dans la création d'unités de conservation ou unités d'intérêt écologique; une nouvelle liste nationale des rivières à saumon; des traités sur la biologie, le cycle biologique et les groupements de stocks; de l'information sur la régulation des populations, l'état et les tendances du stock, ainsi que sur les besoins en matière d'habitat et de résidence. Il a également été question des prédateurs et des proies du saumon, des statistiques de prises et de débarquements et des obstacles au rétablissement des populations.

Dans les éléments d'information nouveaux il faut citer l'ajout de près de 140 rivières aux quelque 550 rivières à saumon de l'est du Canada auxquelles il est souvent fait référence; une analyse des changements dans l'abondance des adultes au cours des 15 dernières années, qui, selon la méthode et les critères retenus, laissait entendre qu'environ la moitié des 20 zones de pêche du saumon pourraient être considérées comme se prêtant à un certain degré de « rétablissement ». Les données les plus récentes semblaient toutefois indiquer que les tendances à la baisse de l'abondance de certaines populations de saumon atlantique de l'est du Canada a atteint son seuil et qu'elle pourrait, exception faite des populations situées le plus au sud, être en train de remonter. Bien que la survie en mer soit considérée comme le plus grand obstacle commun à la hausse de l'abondance, des facteurs liés à la densité en eau douce pourraient aussi contribuer à limiter le rétablissement dans certaines rivières.

Au cours des nombreuses discussions qu'ils ont eues, les participants à l'atelier ont indiqué que, dans le tracé des limites des unités de conservation ou unités d'intérêt écologique, il faudrait tenir compte non seulement de la génétique moléculaire, mais aussi de la biologie, des caractéristiques du cycle biologique, de la morphologie, de la géolographie et des objectifs utilisables pour la gestion. Ils ont convenu aussi que l'information publiée au sujet de la génétique moléculaire des populations de l'est du Canada était à elle seule inadéquate pour permettre de délimiter plus d'une unité. Ils ont discuté de la manière de calculer et d'interpréter le « pourcentage des besoins de la conservation » et le « pourcentage de déclin » sur un laps de temps donné pour déterminer l'état du stock, qui, pour ce qui concerne le nombre total d'individus adultes, n'était pas toujours conforme aux autres « indicateurs ». S'agissant de la formulation d'un avis sur le rétablissement dans le contexte de la Loi sur les espèces en péril, les participants s'entendaient pour dire que le point de référence limite opérationnel standard, soit 2,4 œufs/m2 ou une variante de ce dernier, ne convenait pas, en raison de la variabilité de l'habitat entre les rivières d'une même Région ainsi qu'entre les rivières de plusieurs Régions et de l'absence de critères de détermination du risque. En fin de compte, il a été convenu qu'il faudrait davantage de travail pour parvenir à des analyses et à une description consensuelles de l'état du stock, de ses tendances et des objectifs de rétablissement.

INTRODUCTION

Fisheries and Oceans Canada (DFO) Species-at-Risk-Act (SARA) Office awarded funds to the federal Atlantic salmon science community to begin the development of a 'Conservation Status Report' (CSR; Appendix 1) in 2005-2006. The report, once finished in the next or following fiscal year(s) could support and/or react to a potential assessment by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Elements of the first year's effort could also provide immediate background to an implementation plan for a renewed Wild Atlantic Salmon Conservation Policy and inform a government-proposed Atlantic Salmon Endowment Fund.

Participation in this phase was limited to the Science community within DFO and the Province of Quebec. Over the course of eight teleconferences, June 2005 - January 2006, those scientists proposed and developed a more definitive product, specifically a chaptered document describing in larger detail what is known about the biology and status of wild Atlantic salmon in Atlantic Canada and Quebec (Appendix 2). That document was to be comprised of assigned topics/ sections including analyses and perspectives of a large biological data base encompassing all monitored populations and was to be submitted for publication in the DFO Technical Report Series. Supporting stand-alone elements to the chaptered document were to have been targeted for inclusion in DFO's Research Document Series of the Canadian Science Advisory Secretariat.

A workshop was scheduled for February 13-17, 2006, at the Gulf Fisheries Centre, Moncton, NB, to review and discuss the assigned contributions (subsequently referred to as Working Papers) to the chaptered document and their conclusions, any supporting stand-alone potential Canadian Science Advisory Secretariat (CSAS) documents, and the elements that were transportable to a Conservation Status Report framework developed by the Department's Species at Risk Office. There it was hoped that, at a minimum, one could describe the status of stocks by Region and possibly Salmon Management Area in terms of selected criteria and begin the discussion on the definition of conservation/ ecological significant/ designatable units and the research necessary to draw conclusions.

The workshop was attended by nine DFO biologists/ scientists and one Quebec provincial biologist directly engaged in the research/ assessment of Atlantic salmon, four DFO collaborators, external reviewers from the Pacific Region(2), Memorial University of Newfoundland(1), and the Atlantic Salmon Federation(1), and a consultant (Appendix 3). The role of the consultant was to assimilate relevant elements of the chaptered documents (Working Papers) into the framework of the Conservation Status Report.

Tabled documents approached 500 pages in total and revealed the enormity of the proposed task of publishing a single chaptered document. During the Workshop a proposal from the floor was made and accepted to abandon the concept of publishing the chaptered document in favor of having each author upgrade their chapter/ section (Working Paper) to a Canadian Scientific Advisory Secretariat (CSAS) Research Document (Working Papers [WP's] and later assigned Research Document numbers provided in Appendix 4). The chaptered document framework (Appendix 2) had however guided the contributors and agenda to that point and remained the sequential order of the Workshop. That order of presentation (Appendix 5) of chapter/ sections WP's was varied because of winter storm events on both the opening and closing days and the need to facilitate the possible formation of subgroups within which to extend analyses during the workshop. The following record reflects the sequence of events at the Workshop.

Margaree and NW and SW Miramichi) appears higher than that of Bay of Fundy and Nova Scotia Atlantic coast rivers.

For smolt-to-1SW comparisons in the marine environment, most density dependent models produced infinite estimates of the carrying capacity and as such were virtually identical to the fit by the density independent models. Density dependence was not detected in any of nine smolt-to-2SW returns.

Discussion and Conclusions

Reviewer: This is an interesting and informative analysis, and it highlights the amount of information that exists within the Canadian range for salmon. The analytical techniques are up to standards.

- although each river system will be different, it might be worth commenting on whether there is any potential for bias in the results by the choice of electrofishing sites that are in the database - if the sites are mainly for assessing one life stage, then inferences about other stages may be limited if those stages move to other habitats or are not available to the gear
- although the data are presented in the O'Connell paper (WP 014), it might have been illustrative to have egg-to-smolt relations presented here to show the summary of the effects of survival of the intermediate stages that is illustrated by the fry-parr analysis
- ultimately it would be nice to be able to ascribe the differences in the form of density-dependence among rivers to some attribute of them. If habitat data were collected perhaps variables such as flow, substrate size and composition, productivity etc. might be important
- a complementary analysis of size data might also be informative
- the question of spatial coherence in survival rates is an interesting way to evaluate global or regional effects due to weather, snow pack etc. - this could be done by taking the residuals from the fitted models and putting them in correlation matrices (lined up by brood year for freshwater and smolt year for the ocean). I did something like that for coho smolt production in freshwater using Myers' correlation by distance approach—see (Bradford, 1999), wherein I found that spatial co-variation in freshwater occurred only at very local scales; Randall Peterman has done a lot of work on marine co-variation in recent years
- the non-stationarity in the marine data is an important issue; time series plots of smolt survival rates (or residuals from the Stock Recruit relationships) could be evaluated by the methods provided in the relatively new book by Walters and Martell (2004)
- comments about the capacity (K) for each stream (and the variability) should be in the context of the sites that were actually sampled- and whether they are reflective of river-wide densities
- in reviewing the outer Bay of Fundy status document (WP 025) I see for the Nashwaak that there are earlier years in which the fry densities are three times the values of those in this document (the analysis was apparently limited by the spawner time series); there are fry densities of 40-60/100m^2 which would suggest that the curvilinear relation in Figure 1 for Nashwaak fry is biased and that actual capacity for the system might be much higher than indicated by the model (at least for fry) - this of course is the common problem of the over-estimation of density dependence in short series (with limited contrast) for which little can be done except to be cautious about interpretation.

Working Group: A number of considerations were voiced and included:

- the use of return rates to correct for changes in marine survival
- the need to consider the correction for consistency/ variability in the habitats (e.g., fry vs parr) and their carrying capacity (site selection) sampled by electrofishing, i.e., and this may change the perception of carrying capacity among rivers and may make variability greater; survival > 1 may also partly result from sampling bias for life stages
- an examination of common trends in residuals across all fits relative to factors such as climate variability
- the possibility that autocorrelation in time series may affect conclusions on density dependence - residuals around SR curve are not random and therefore curves may bend over because of that effect rather than density dependence
- the possibility of constraints on over winter survival as a result of bed load movements

References

Bradford, M.J. 1999. Temporal and spatial trends in the abundance of coho salmon smolts from western North America. Trans. Amer. Fish. Soc. 128:840-846.

Walters, C.J and S.J.D. Martell. 2004. Fisheries Ecology and Management. Princeton Paperbacks. 399p. http://www.pup.princeton.edu

Freshwater Habitat Requirements of Atlantic Salmon (WP 017)

Presenter: P. Amiro
Reviewer: J. Irvine
Rapporteur M. O'Connell

WP Summary: A definition of habitat is proposed and a summary of its diversity and use is presented. Physio-chemical and geomorphological constraints on population dynamics and production are identified. A discussion of anthropogenic impacts (e.g. acid rain, man-made obstructions) on habitat and production and an overview of the current status of Atlantic salmon habitat are provided. The issue of crucial (critical) habitat is addressed.

Discussion and Conclusions

Reviewer: This appears to be a thorough review of the literature on freshwater habitat requirements for Atlantic salmon - Appendix 1 is particularly useful. However, certain technical terms need to be defined and the text table needs to be documented. It may be worth contacting Pacific staff about approaches to summarise freshwater habitat on a Conservation Unit basis.

- it is good to see the objective stated (last paragraph, 4.1.1.1), but why is the document restricted to juveniles i.e. is it not important to consider freshwater habitat for spawners and pre-spawners?
- the report starts by introducing the definition of habitat and how habitat definitions have taken on various meanings; I interpret salmon habitat as essentially anywhere that salmon live and cite the Fisheries Act (Section 34) (or SARA) definition: "spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes"
- para 3 states that common terms such as runs, riffles, cobble, etc. do not have standardised definitions; my understanding is that these terms have accepted definitions, especially for the substrate particles
- terms that I think need to be defined or their use re-considered include (but in some cases this depends on who the audience of this chapter are):

  - "classic" habitats, last line of p 1, p 3, line 2, apparently Atlantic salmon jargon which is not needed?
  - local populations, p 2; use population structure?
  - productivity (rate of population increase) and production (size of population), p 3, lines 6-7; are these the accepted definitions in the Atlantic salmon literature, and if so, cite references?
  - unsustainable, p 8, line 3, last para; do you mean population will become extirpated?
  - conservation, p 13 and elsewhere; preservation? and 'wise use' (p 14)
  - crucial habitat (p 13), critical?
  - recovery targets (p 14)?; benefits (p 15)?
  - "moderate" temperatures
- 4.1.1.3, p 4. para 1 confusing; free and despotic distributions? Provide example? Hayes et al, (1996) and Poff and Huryn (1998) are not cited in the references
- p 4, para 3, do we agree that freshwater habitat is more constraining than marine habitat?
- statements (p5, bottom paragraph) about population declines despite closures seemed out of place; perhaps these statements should be used to introduce the chapter?
- Table (p7) is confusing; what is the source of these data? sample sizes?; is the mortality for just that life stage? and are these ranges? - some of the mortality changes are quite remarkable if they are real (e.g. relatively small increase in pH effects on smolt survival)
- siltation (p 11) – is this section missing?
- climate change – impacts on freshwater production of salmon through alteration of flow and temperature regimes may be huge; this important area may deserve additional discussion here if it is not considered in detail elsewhere
- summary conclusions (p 13), not clear what the first bullet means.
- why are the summary conclusions before the end of the chapter?
- no acute loss of habitat? - is this true throughout the distribution?; what about culverts along the new Labrador Highway?
- crucial habitat - seems as though you are describing critical habitat but you do not want to be constrained by the legal ramifications of calling habitat critical?
- A few topics that might deserve more attention:
  - lake habitat - chapter focuses on river habitats although, at least in Newfoundland, lakes are important
  - role of cover and riparian vegetation
  - gradient
  - pre-spawning holding habitat and spawning habitat

Working Group: There is an apparent need for an all encompassing inventory of Atlantic salmon habitat which is not currently satisfied by the NASCO list of rivers now under development. This list is a work in progress and continues to be updated as new information becomes available. Populating this list could be very costly, depending on the level of detail e.g., a lot of information is currently available, for example through satellite technology. There should as well be an effort to coordinate efforts with European interests.

It was also noted that there are considerable pristine areas in more northern areas and loss of habitat in southern areas would not necessarily result in a substantive loss of overall productive capacity.

Residences of Atlantic Salmon (WP, no number assigned)

Presenter: J. Gibson
Reviewer: J. Irvine
Rapporteur P. Amiro

WP Summary: The document reviewed acts, definitions and literature concerning the definition of residence under the Species at Risk Act and suggested that redds, home stones, and staging pools potentially met the definition of residences.

Discussion and Conclusions

Reviewer:

- identifying what constitutes residence under SARA for salmon is a challenging task without real precedent; this short section is a good start but I suspect this topic will require considerable debate before a consensus is reached on what constitutes residence
- this section (along with some of the others) would benefit from a short statement giving the objective
- I seem to recall a DOE report on SARA residence that I believe mentions stickleback nests as example of a residence - reference this report?
- discuss how critical habitat is differentiated from residence - perhaps, residence is habitat essential for *individuals* while critical habitat is essential at the *species* level, for survival/recovery
- if a particular home stone or staging pool is considered to be a residence, and that stone or pool is removed/ made inaccessible, and the individual salmon moves to another stone/ pool and survives, was it correct to label the original stone/ pool as residence? YES
- it might be worthwhile discussing/ speculating on the management implications of identifying residence - are there legal or other implications as there are for critical habitat?

Working Group: The document and the lack of a known DFO definition generated a great deal of discussion on the possible definition and interpretation of a residence, i.e., how the term differed from what would be critical habitat, if it was designed to protect areas not designatable by critical habitat and if it included water. There was a general concurrence that the term 'residence' was targeted to protect specific habitats important to life stages of individual fish before and after listing *while the recovery plan was being developed.* There was no concurrence that "construction" as in a "redd", was a necessary qualifier. Participants wondered if the definition would include staging areas, winter residences of parr and kelts, spawning and estuarial staging areas.

Marine Habitats of Atlantic Salmon (WP 018)

Presenter: D. Reddin
Reviewer: M. Bradford
Rapporteur R.A. Jones

WP Summary: The paper/ presentation highlighted some aspects of Atlantic salmon ecology in the Northwest Atlantic Ocean. Information such as tag returns, scale and genetic analysis from commercial catch data and marine research studies provides the bases for marine distribution and migration of Eastern Canadian Atlantic salmon. Closure of the Canadian and reauction of

the Greenland commercial fisheries has significantly reduced the data collection opportunities. New information from data storage tags placed on a few smolts and kelts and recovered after sojourns at sea provided insights to depth and temperature preferences.

Discussion and Conclusions

Reviewer: This is a thorough review of our understanding of the marine life of salmon. The paper could benefit from some editing as there appeared to be some things that came up more than once in the discussion. Other points:

- consider inserting some of the maps (particularly those used for the presentation) that provide some landmarks and show key migration routes
- the key issue is the apparent decline in ocean survival in recent years. I would have liked to have seen some "state of the ocean" analysis with time series of some of the oceanographic factors that might be involved

Working Group: It was recommended that some of the figures from the Powerpoint presentation be included in the document, in particular, a figure indicating place names.

- with reference to the decline in smolt-to-adult survival observed in Western Arm Brook, Newfoundland data – it was asked if this could be correlated to changes in oceanographic conditions? The response was that there was no correlation between the survival data and the North Atlantic Oscillation (NAO) index; also there is very little or no evidence that the salmon returning to our rivers were smaller in size
- there was a recommendation that there be a section on the ocean current patterns and documentation of the fact that there is no correlation between the NAO index and either pre-fishery abundance or Newfoundland smolt-to-adult return rates
- there was some discussion on the timing and magnitude of the lower smolt-to-adult return rates observed in the presentation of the Western Arm Brook data. There was a suggestion that the Western Arm Brook data was indicating an earlier reduction in sea survival compared to other rivers and that the magnitude of the decrease may be a function of having adjusted the adult returns to Western Arm Brook during the years of the commercial fishery
- the author provided two internet sites tracking marine environmental data: that of the NAO Index http://www.cru.uea.ac.uk/~timo/projpages/nao_update.htm and the Continuous Plankton Recorder (CPR) data located on the Sir Alister Hardy Foundation for Ocean Science (SAHFOS) website at http://192.171.163.165/
- a question was posed about available data to determine the direction of post smolts in the North Atlantic. Response – the work done by Meister (1984) and Montevecchi, Cairns and Birt (1988) indicated post smolt movement from the south to the north. Dave noted that his sampling indicates post smolts are present in the Labrador Sea during the months of September and October and that post smolt distribution east of Greenland and north of the Faeroes is relatively unknown. The possibility of salmon of North American origin being captured in the Faeroes fisheries is minimal given the paucity of tag returns of North American origin from the Faeroes fisheries. Concern was expressed however, about the equality of reporting rates by countries. Genetic sampling and analysis of salmon captured in the Faeroes fisheries could provide some insight into the contribution of North American salmon to these fisheries.

References

Meister, A.L. 1984. The marine migrations of tagged Atlantic salmon (*Salmo salar* L.) of USA origin. Cons. int. Explor. Mer, C.M. 1984/M:27, 28p.

Montevecchi W.A., D.K. Cairns, and V.L. Birt. 1988. Migration of postsmolt Atlantic salmon, *Salmo salar*, off northeastern Newfoundland, as inferred by tag recoveries in a seabird colony. Can. J. Fish. Aquat. Sci., 45: 568-571.

Salmon as a Predator and Prey (WP 019)

Presenter: D. Cairns
Reviewer: J. Irvine
Rapporteur F. Whoriskey

WP Summary: As juveniles in fresh water, Atlantic salmon feed on a variety of invertebrates. During summer, they eat during both day and night, but in winter they are night active only. Seasonal patterns in feeding intensity track energy demands for maintenance, growth and precocious maturation. Smolts feed heavily on freshwater invertebrates on the way out to sea. In the ocean, salmon feed more intensively in spring and summer than in winter, and achieve much faster increases in body size at sea than in fresh water. They appear to take prey opportunistically, may be able to filter-feed, and can shift to piscivory at a body length of about 25 cm.

Predators of salmon in fresh water and at sea are varied, and include birds, mammals, and fish. In fresh water, birds such as mergansers may take large numbers of juvenile salmon, but this does not appear to depress juvenile populations, suggesting they are subjected to compensatory mortality. At sea, limited data suggest gannets may be a significant predator. However, if known ocean predators consumed 100% of a given North American post-smolt cohort, salmon would comprise only 0.04% of these predators' diet.

In freshwater, juveniles may compete with other salmonids for food and space, however at sea there is little evidence for this.

Discussion and Conclusions

Reviewer: This is a thorough review of predator prey situations involving Atlantic salmon and my comments are minor:

- Table 4.3.1 is a useful summary of salmon predators; a similar style of table summarising prey, separated by life stage and environment (stream, lake, estuary, and ocean) would also be useful
- the European literature references enhance the text, however, several do not appear in the Literature Cited
- lake residing salmon were largely ignored, i.e., there should be specific mention of salmon prey and predators in lakes
- although the chapter is on salmon predators and prey, I recommend expanding the context to more fully describe the role of Atlantic salmon in the ecosystem especially the role that Atlantic salmon have in transporting marine nutrients back to the freshwater ecosystem

Working Group: The question was raised about whether the present decrease in salmon abundance may have depressed smolt numbers to the point that school/ shoal formation at sea has been impaired, thereby reducing the schools potential anti-predator and food finding advantages. The author indicated that there was, to his knowledge, no information available on the schooling/ shoaling behavior of salmon at sea that could be used to address the question. It was also pointed out that in Newfoundland, there is a data knowledge/ gap on the use by juvenile salmon of lacustrine habitats for feeding and rearing. The role of returning Atlantic

salmon as a nutrient pump for freshwater ecosystems was also discussed. It was felt that other anadromous species like gaspereau (*Alosa pseudoharengus*) are probably a more significant nutrient pump, given their abundance and mortality rates in freshwater.

Replacement Ratios and Rebuilding Potential for two Multi-Sea-Winter Salmon Stocks of the Maritime Provinces (WP 027)

Presenter: G. Chaput
Reviewer: F. Whoriskey
Rapporteur: J. Gibson

WP Summary: An analysis and comparison of two salmon populations was presented in the context of the potential for rebuilding stocks. Between 1971 and 2005, the Miramichi population has fluctuated and has been both above and below the spawner conservation requirement. In contrast, the Saint John River population upriver of Mactaquac fluctuated around its spawner conservation requirements from 1970 to about 1985, after which it has been more or less continually declining. Replacement ratios (lifetime eggs produced by a spawned egg) were calculated annually for each population. Replacement ratios have recently been above one for the Miramichi population but have continued to decline for the Saint John River population. Other differences in the population are an increased number of repeat spawners and increased number of the year classes contributing to spawning each year and an increase in fork length in the Miramichi, none of which are changing on the Saint John River. The potential for rebuilding on the Miramichi appears to be positive, whereas the outlook for salmon populations on the Saint John River upriver of Mactaquac appears poor.

Discussion and Conclusions

Reviewer: These are extraordinary data sets, as are many of the others presented at these meetings. DFO is to be commended for generating them.

- given the intention to publish these documents individually now, as opposed to within a single document, many are going to have to be expanded so that they can stand alone. Before they were supported by companion papers planned for the same volume. In this paper, an example is the discussion of Nashwaak River patterns at the end of the text, no supporting data are provided which is, I presume, because they were originally planned to be presented in other supporting documents
- a definition of "rebuilding potential" would be useful as would a general sense of the salmonid life history strategies (especially repeat spawners) and the consequences for population dynamics. Another key dynamic is the ocean survival issue. Very small changes at sea have huge impacts on the number of returning adults. Perhaps some of the reverses from record low returns to record high returns recently on the Columbia River for Pacific salmon would be good general examples to cite
- is an egg an egg?; the general tenant of the scientific literature is that older, more experienced breeders have higher fitness, for a variety of reasons, including higher gamete quality and more successful behavior. This is worth considering in the paper, and possibly in future research
- is it worth revisiting the fecundity calculations? These use relatively old data. Given recent results suggesting correlations between egg sizes and juvenile salmon growth rates, and the documented changes in growth rates you are observing for the juvenile fish compared to historic patterns, this may be worth reexamining
- the document leaves the reader with a sense of the recovery potentials for two river systems, the Miramichi and the Saint John. This is not expanded into a sense of the

degree to which the results from these rivers can be extrapolated to other neighboring (dare I speculate fellow Conservation Unit?) river
- discussion on the Miramichi focuses very much on density dependent events in fresh water, and ultimately the high juvenile numbers and these correlations probably indicate that fresh water production is saturated at historically high levels. Given these circumstances, "rebuilding" (increases in numbers of returning adults) to historic levels will be dependent on improvements in marine survival. This is not discussed. Similar considerations of marine survival should be discussed for the Saint John system

Working Group: A question was asked about the trend in the return rates of hatchery fish. Trends are similar to the Pacific Coast. They appear good initially and then drop. Could they be compared with the wild return rates by year of ocean migration and would they be more similar if presented that way?

The question was raised about whether the change in repeat spawning survival is a result of the turbines at Mactaquac coming on line. The response was that the decline appeared to occur a bit later. Have other factors changed? Fish such as smelt and likely others play an important role in reconditioning kelts. Is their abundance changing? The answer wasn't known.

Is over-compensation occurring in the Miramichi population? The smolt data suggests it may be, but it cannot be separated from a regime shift in the SR analysis. If it is occurring, is it bad? Although a loss of production may be entailed, the distance between the SR curve and the replacement line is greater over much of the data than if a Beverton-Holt model was fit to the data, as a result the population may be more resilient.

The point was made that turbine mortality affects the slope at the origin of the stock-recruitment model, and that the expectation is that the Saint John River would have a lower slope because of the hydroelectric development on the river. The suggestion was made to add a stock recruitment line to the plot in Figure 8 [Stock and recruitment relationship for wild salmon from the Miramichi River (upper) and Saint John River (lower). Returns are the life time egg contributions for all age groups of the year class]. This would show the difference in the slope at the origin between the two populations.

Factors other than turbines and freshwater effects may also be affecting productivity based on the decline of most other Bay of Fundy populations. Is stocking a possible cause? The observation was made that when the hatchery component in spawning populations is high (e.g., greater than 50%) survival of progeny seems to drop. In the Saint John River, not all hatchery origin fish can be identified because those released at younger ages (fry) are not always marked.

Discussion eschewed about whether the data could be used to determine when a shift in natural mortality occurred. It could be possible but there may have been more than one change, particularly in the Miramichi population.

A question was raised about the use of the term "rebuilding potential". Rather than stating that the Saint John population prognosis is negative, why not state that rebuilding of the population is dependent on the identification and alleviation of the causes of high mortality in the population. This approach would help focus recovery efforts.

Reference Levels and Conservation Requirements (WP 021)

Presenter: G. Chaput
Reviewer: M. Bradford
Rapporteur D. Cairns

WP Summary: Reference points (RP) are signposts against which we assess performance. These are defined in terms of biomass/abundance, and removal rates. Target reference points are to aim for; limit reference points are states to avoid. Resource management should aim to avoid surpassing limits. Because of the long hatchery tradition, it is well accepted that recruitment depends on spawner numbers.

In Eastern Canada, the default RP is 240 eggs per 100 m^2. This is the rate which results in "maximum" smolt production. This is derived from Elson (1975) and later taken up by CAFSAC when in the 1980s, there were substantial efforts to develop spawning requirements for eastern Canada. Special consideration was given for lacustrine habitats in Newfoundland. The Sparrow decision said that the native food fishery had first access after conservation, but didn't say what conservation is. CAFSAC said that 2.4 eggs per m^2 meet the court's definition and in 1996, 2.4 was defined as a "limit reference point". This is the threshold for closing a native fishery.

In 1999 Quebec calculated a reference level of 1.68 eggs per salmon production unit (m^2) that is itself calculated on the basis of an index of juvenile habitat quality. The 1.68 value is based on stock-recruitment analysis and habitat data. Conservation requirements have yet to be fully defined in acid impacted rivers, where habitat productivity is less than other areas, and in Labrador, where data are incomplete.

RPs are used in opening and closing rivers, and for management of high-seas mixed-stock fisheries. Science agencies have not yet proposed methods for setting management targets. The use of 2.4 today assumes that the population dynamics of earlier times still apply.

The term conservation in the context of reference points is unfortunate, because conservation has a variety of definitions. We should use *designatable* unit or some other word, so as to avoid the use yet again of "conservation."

Discussion and Conclusions

Reviewer: This is an interesting narrative of the development of "conservation requirements" for Atlantic salmon in Canada. I can't comment on the veracity of the events but it certainly sets the stage for future developments.

- "conservation" has generally referred to having sufficient spawning potential to achieve close to optimal smolt production in each Atlantic salmon river. It is useful to ask whether this is an appropriate approach when stocks are approaching SARA or COSEWIC considerations. In the US, west coast population viability is a multivariate consideration of abundance, productivity and diversity (McElhany, P. 2000).
- the evaluation of reference levels for salmon will depend on the level of aggregation. Setting a reference level of a few hundred fish would suggest that a population at this level of abundance will be at considerable risk of extinction if it was isolated (unless the productivity was very high). Thus there is potential conflict between the use of the historical conservation requirements on a stream-by-stream basis, and an evaluation of the extinction risk in the case of the relatively small streams. This can be resolved by consideration of the demographic interchange among adjacent streams that couples them in a larger meta-population. However, I would guess that the risk of extirpation of a

small population (stream), even when it is at 'conservation' is greatly enhanced when the productivity has declined, as it has in many populations

Working Group: The current reference point system is good for setting fishing rules, but not so useful for other purposes, such as dealing with risk of extirpation. Conservation of populations, their diversity and habitats is a mandate. There are various precedent terms: assessment unit, designatable unit, etc., Pacific Region however focused on the term 'conservation unit' but was unsuccessful in an attempt to define conservation in a legal sense. It was noted that on the east coast, the courts upheld the DFO definition of 'conservation' in a 1995 case concerning native fishing.

A discourse on Pacific's approach in assessing the status of conservation units followed. There, Science made sure that the objective of 'conservation units' was clear and didn't use "reference points" because they recognized that 'Science' was but one of several contributors to the determination of targets. Science designates lower and upper benchmarks and classifies population status accordingly. This information is passed to managers, who incorporate socioeconomic information before deciding on the target. The lower benchmark would appear to be similar to Atlantic salmon reference points, e.g., 2.4 eggs per m^2 but there is not a single formula for defining the lower benchmark. A small buffer exists between the lower benchmark and a point where COSEWIC would declare a species at risk. The upper benchmark is normally S_{msy} and the zone between the benchmarks is the amber zone. Previously, managers sometimes aimed at limits, rather than targets and in doing so provided little reaction time when populations were unpredictably low. Courts permitted DFO to allow fisheries on a population below the reference points but usually only under the guise of by-catch.

From a legal perspective it was noted that if a procedure is properly thought out and due process is followed, the courts will side with DFO.

References

Elson, P.F. 1975. Atlantic salmon rivers, smolt production and optimal spawning: an overview of natural production. Int. Atl. Salmon Found. Spec. Publ. Ser. 6: 96-119.

McElhany, P. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. US Dept. Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Seattle, WA.

Allowable Harm Permitting (AHP) as Applied to Atlantic Salmon (an informal presentation)

Presenter: P. Amiro
Rapporteur: L. Marshall

Summary: Section 1.6 of the CSR Framework 'Scope for Harm' was largely unaddressed by any of the Workshop's presentations. The presenter provided a tact by which Live Gene Banks might be deployed to buy time for small unstable/ vulnerable populations of Atlantic salmon, specifically the inner Bay of Fundy populations, for which recovery targets are vague, there is little probability of immediate recovery and which would under the Act require prosecution of anyone harming, harassing etc. members of the population. Populations that could be supplemented, even if only in freshwater to the point where the Conservation Unit was no longer below a 'critical/ cautious' boundary would facilitate the issuance of an AHP i. e., harm would

not impede recovery, and forego a potential need to prosecute 'industry/ by-catch fisheries' or cause the Minister to revoke the listing.

The presenter reviewed the key elements of 'A Framework for Developing Science Advice on Recovery Targets for Aquatic Species in the Context of the Species at Risk Act' (DFO 2005) which indicated that the "precautionary framework" currently being finalized for fisheries management was considered suitable as the starting point for recovery of Species at Risk.

The framework (DFO 2005) has three zones for a population: healthy, cautious, and critical, but currently there is no compelling *science* argument pointing definitively to positions between or within the zones. Recovery plans which aim to increase biomass or abundance to the cautious-healthy boundary are expected to result in stocks being clear of a COSEWIC 'threatened' or 'endangered' designation, whereas recovery plans which only aim to increase a population to the critical- cautious boundary, may result in a COSEWIC assessment that concludes that the population is in the medium term, at unacceptable risk of extinction. Attributes to include in a description of 'recovery' and address recovery plans was determined to be: direct measures of abundance and total range occupied e.g., an abundance goal in the context of the historical population size, a population growth rate or level of surplus production, an age composition, and an abundance-weighted description of range (DFO 2005).

The proposed approach for the iBoF populations was the supplementation of key populations to the point where, in a generalized egg to smolt equilibrium model, supplementation resulted in an intersection of the replacement line and production curve.

Discussion and Conclusions

The use of the equilibrium model with some modifications appeared to be an area deserving of exploration/ refinement.

References

DFO, 2005. A framework for developing science advice on recovery targets for aquatic species in the context of the Species at Risk Act. CSAS Sci. Adv. Rep. 2005/054: 16p.

APPENDIX 1

CONSERVATION STATUS REPORT
SARCEP - Terms of Reference (2004)

Context

DFO Species Priority List

What:
- DFO priority list based on biological and socio-economic information

How:
- DFO and other jurisdictions (possibly through CCFAM) would identify priorities for assessment through general status, COSEWIC Priorities etc.

Why:
- Identification of species requiring conservation measures
- DFO staff (potentially in partnership with other jurisdictions) would develop Conservation Status Reports that would form the basis of a COSEWIC status report, allowable harm assessment and recovery strategy
- Allows for the development of annual/regional species work plans to maintain equitable division of labour

Conservation Status Report

What:
- Conservation Status Reports that would form the basis of a COSEWIC status report, allowable harm assessment and recovery strategy
- DFO and not SARA language used
- DFO would subsequently submit COSEWIC status report for consideration (potential for no submission)

How:
- DFO initiates an Assessment (see content below)
- Assessment is reviewed through Advisory Processes (which includes stakeholder participation)
- Enables DFO to implement pre-emptive management measures prior to listing
- Increases transparency & stakeholder involvement in process
- Integrates the SARA process into normal DFO operations
- DFO would use the outcome of this assessment to consult with stakeholders and implement management measures (if possible)

Why:
- Provides ample lead-time to consult with our stakeholders
- DFO would have the information required to prepare for listing
- Provides better info to COSEWIC
- Potentially prevent unnecessary listings
- Decreases duplication of effort

- as with most of the reports on status, these reports deal with information on the index streams only, and have little reference to other salmon streams in each area (with some exceptions) - it would be useful to put the index streams in context, perhaps by mentioning roughly how many salmon streams are in the area, and the overall significance of the index streams
- outer Bay of Fundy: the figure "1+ smolt distributions.." is unclear, I'm guessing these are smolt releases from the hatchery
- are the "outlook" sections appropriate? - if so the methods (or citation of approved methods) are required.
- eastern Cape Breton—p 3 mentions "catch rates" but these are not explained nor are units given- is this the proportion harvested?
- the middle paragraph on p 5 refers to a variety of data that are not found in the report; Figure 6 of this report – a power function or other model should be used- the linear one fitted has a large positive intercept which is not biologically reasonable
- Quantitative rates of decline would have enhanced the descriptions/ illustrations

Working Group: Discussion touched on the interpretation of the spring southern extent of the Labrador winter ice used to moderate early expectations of returns to the LaHave River (only) and implications of marine temperatures in survival but was inconclusive. Discussion shifted to constraints in freshwater that were seemingly contributory to low production of juveniles relative to expectations. This was evident to some, especially in the Saint John and its Nashwaak tributary – data which might have been included in this presentation but for reference purposes could be found in a later tabled document (WP 027) contrasting production rates and rebuilding potential of the Miramichi and Saint John rivers. Trends in repeat spawners were queried, especially in the Saint John, where unlike the increase in the Miramichi River, the trend varied between downward and none at all. The author noted that downward trajectories in repeat spawners represented, in some cases, significant reductions in egg depositions that had been in most cases a bonus to calculated egg conservation requirements. A general discussion ensued on 'equilibrium' models and how, on rivers unaffected by acid precipitation in the Southern Uplands, e.g., Gold and Musquodoboit, persistence was in jeopardy because of low marine survival, i.e., replacement was now not being met.

Atlantic Salmon Fisheries in Canada (WP 020)

Presenter:	R.A. Jones
Reviewer:	I. Fleming
Rapporteur	C. Bourgeois

WP Summary: The document provides catch data and the sources of these data for the five eastern provinces of Canada. Data spanned the period 1910 – 1999, the later when commercial fisheries ceased in Canada. The three remaining primary users of salmon are Aboriginal peoples, residents fishing for food in Labrador and recreational fishers.

Annual commercial harvests in New Brunswick, Nova Scotia and Prince Edward Island, Newfoundland and Labrador and Quebec were provided as proportions. Estimated harvests of North American salmon captured at West Greenland, 1982-2004 and commercial and recreational harvests for St. Pierre et Miquelon, 1990-2004 were also provided.

Recreational harvest data is supplied for Canada from 1974-2004; hook-and-release data is supplied for 1984-2003 with some exceptions. Recreational harvest data is presented for each of the five provinces for the time periods available. Harvests by Aboriginal peoples are not presented.

Discussion and Conclusions

Reviewer:

- suggest adding a few sentences at the beginning setting the scope of the document and its objective(s) – introducing all the types of fisheries to impact or which have impacted Canadian Atlantic salmon (much like what was given during the presentation)
- p 5 - define: (1) license stub return, (2) catch estimate system and (3) DFO Conservation and Protection Officer report estimates
- information on (1) native fisheries, (2) poaching, and (3) by-catch would be very useful
- appendices are very useful, even if they are incomplete, it provides the start for a more complete compilation
- unreported landings – what is encompassed and are they included?

Working Group: The goal of the paper should be included in the 'Introduction' e.g., to summarize the harvests of Canadian-origin Atlantic salmon and document the management changes in the various fisheries. Establishment and mention of a central depository would also be useful.

There was some concern that earlier by-catch figures were unreasonably low and could impact on the abundances used for ICES. Thus it was suggested that research vessel cruise data set might be a good starting point to re- examine the issue, e.g., gillnets and other legal gear. It was also noted that total landings were not reported from PEI and that landings were only reported from licensed gear possibly not including bait traps and weirs. Licensed and unlicensed catches both appear in the Maritimes Region 'Red Book' series and that data should be checked for inclusion.

It was also noted that there was no angling catch provided for New Brunswick over the last 11 years despite the inclusion of an estimated percentage loss to hook-and-release mortality in annual assessments.

<u>Population Regulation in Atlantic Salmon (WP 016)</u>

Presenter:	J. Gibson
Reviewer:	M. Bradford
Rapporteur	G. Chaput

WP Summary: The document focuses on compensatory density dependence wherein survival between life stages is assumed to be a decreasing monotonic function of the population size, and maximum survival occurs at the origin. The author then uses data from nine rivers in the Maritime Provinces and approximate maximum likelihood algorithms and three stock-recruit models (a density independent function, Beverton-Holt, and Ricker) on egg to juvenile survival to investigate the timing and nature of density dependence in freshwater habitat and on smolt to adult return rate data for 15 populations in Eastern Canada to evaluate whether there is evidence for density dependence at sea.

No consistent pattern was found in the timing of density dependence in freshwater, the data were however more informative about the nature of density dependence, i.e., the Beverton – Holt model is a better overall fit and contained more information about the habitat carrying capacity than the maximum age-0 to age-1 survival. Also, with the exception of the Stewiacke River, the carrying capacity for age-1 parr of the Gulf of St. Lawrence rivers (Restigouche,

- Proceedings and Part 1 of the Conservation Status Report are produced.
- Science (National Headquarters) formally informs operational sectors on outcome of Allowable Harm Assessment (AHA) (Phases 1 & 2).
- DFO Sectors and other jurisdictions (as required) determine how AHA can be implemented (through integrated management plans, MPAs, mitigation measures and alternative activities to be considered). Includes how to partition harm amongst competing activities.
- Socio-economic analysis and consideration are developed on AHA implementation and impacts of listing.
- Sectoral perspectives are integrated into draft management approach including intent to send status report to COSEWIC.
- Communications strategy is produced (DFO species management strategy and communications plan).

Contents of Conservation Status Report (CSR)— Part 2 —Socio-Economic Report

***Note* This part will be peer-reviewed in a NAP type meeting with all stakeholders/ partners included. The results will be combined with Part 1 to produce the final Conservation Status Report.**

Background:
Methodology, assumptions, limitations

- Identification and description of base case
- Allowable harm assessment/(Fisheries) Management scenarios
- Listing prohibitions; recovery actions

Accounts (As Relevant – All may not apply)

1. Fishing:

a. Commercial fishing sector impacts (Dependence, economic viability and income support)

- Total number of fishers
    - number of licences, permits, enterprises, vessels, persons employed
- Identification of fisheries where there is by-catch
- % of income attributed to species (dependency)
    - Crew members affected
- Geographical distribution of affected licence holders
- Income Support: number of EI recipients by area; average amount awarded by area
- Price trends (landed price and market price per pound by area)
- Fishing enterprises (number, revenue, costs)
- Other sources of income

b. Recreational fishing sector impacts

- Total landings, by area
- Profile of activities affected (employment, value)

c. Processing Sector
- Plants processing species
  - Quantity processed
  - Location (geographical distribution)
  - Cod as a percentage of total processed (dependency, viability)
  - Value added
  - Employment, EI

2. **First Nations impacts**
   - Fishing (Communal licences, FSC allocations
   - Employment, income
   - Economic development impacts

3. **Impacts to other industries** (This may require partnering with provinces for information)
   - E.g., Agriculture, mining, electricity, oil and gas, tourism etc.
     - Activity, production and viability, revenue, wages, employment, costs and net returns

4. **Habitat Enhancements**

5. **Social Impacts**
   - Community Profiles (employment, demographic trends etc.)
   - Regional development

6. **Government**
   - Sectors (federal, provincial, municipal)
   - Revenues (e.g. taxes), costs (e.g. science)

Departmental Recommendation/Proposed Action Plan

- Decision is made on whether to send a species status report to COSEWIC
- If yes, DFO implements management measures prior to COSEWIC listing
- Relevant Sectors consult with jurisdictions, Wildlife Management Boards (WMBs), First Nations, and clients as required
- Implementation of management approach includes promoting stewardship and developing tools/process/system to monitor success or the impact of management measures

APPENDIX 2

Proposed Table of Contents and lead authors for Section 1.0 Conservation Status Report (circa July 27/05). (This approach was later abandoned in favour of using original Terms of Reference Appendix 1 above.)

INTRODUCTION (Marshall)
Summary introduction of species and rationale for conducting CSR (or in this case, a stock status report only) for that species (i.e., rationale and basis for reviewing the conservation status of the species *at this time)*

(state that it follows on stock status information developed for NASCO indicating that abundance of maturing and non-maturing salmon has continued to decline, regional assessments indicating continued decline or lack of recovery of stocks to historical levels despite substantial restrictive management, and to form the foundation document in support of the development of the wild Atlantic salmon policy)

Chapter 1: Description of Species (CSR [App 1.] number 1.1) **(O'Reilly)**
1.1 Name and Classification
- common names
- scientific names
- Linnaean classification
- congenerics
- evolutionary origin

1.2 Morphological Description of the Species
- description of body shape and color

1.3 Identifying Ecological Significant Units (ESUs)

1.3.1 Introduction and Background
1.3.1.1 Goals and objectives
- retaining lineages and evolutionary legacies
- maintaining genetically based adaptations and fitness related traits
- re-colonization within a specified time frame

1.3.2 Population Structuring
1.3.2.1 Phenotypic and genetic differentiation between North American and European salmon
1.3.2.1.1 Summary of phenotypic/parasite differences between North American and European salmon (scales, meristics, morphology, parasites)
1.3.2.1.2 Summary of molecular genetic differences between North American and European salmon
- allozymes
- microsatellites
- minisatellites
- mitochondrial DNA
- time since divergence
- empirical evidence regarding the degree and geographic extent of recent and ongoing gene flow

1.3.2.2 Population structuring within North America
1.3.2.2.1 Colonization of extant populations (source, time frame)

1.3.2.2.2 Stocking and potential for homogenization/retention of pre-existing regional/local structuring

1.3.2.2.3 Summary of phenotypic/parasite differences among regions/populations within North America

1.3.2.2.4 Summary of molecular genetic analyses of among region and among river-within region structuring in North American Atlantic salmon

- original allozyme research
- microsatellite analysis; mtDNA analysis of King et al. (2000 and 2001)
- microsatellite analysis of McConnell et al. (1995 and 1997)
- iBoF mtDNA analysis, submitted broad scale mtDNA analysis and submitted broad scale allozyme analysis of Verspoor et al. (1999 and 2002) plus BIO's recent Maritimes survey

1.3.3 Ecological and Geographic Considerations in the Identification of ESUs

1.3.3.1 Ecological/Life history criteria (Utter et al. 1993) and others

1.3.3.2 Geographic considerations

1.3.4 Integrating Genetic, Phenotypic, Life History, and Geographic Information

Chapter 2 – Distribution (CSR [App.1.] number 1.2) **(Caron)**

2.1 Global Range

- primary reference: Mac Crimmon and Gots (1979)
- secondary reference: Parrish et al. (1998)

2.2 Canadian Range (past and present)

- rivers in eastern Canada (see NASCO database for river listing and qualitative status)
- identify rivers where salmon have disappeared (NASCO database, recent assessment documents,

2.3 Absolute and relative sizes of river runs

- measures of egg requirements to characterize size of rivers (O'Connell et al. 1997a) which puts all rivers on a common scale, there are many small rivers, very few rivers with large (>10,000 fish annually) run sizes
- suggested presentation: histogram to summarize frequency by river size, map to show distribution by river size

Chapter 3 Biology and Life History (CSR [App.1.] number 1.4)
(**O'Connell/ Dempson/ Chaput**)

3.1 Life Cycle

- anadromous and non-anadromous populations (geographic distribution of non-anadromous populations)
  - obligate freshwater spawner
  - picture and brief description of life cycle with references to terms in the glossary (fry, parr, smolt, maiden spawner, kelt, repeat spawner)
- homing: see review and references within by Hansen and Quinn (1998).
- run-timing (smolt run-timing summary, adult run-timing back to the rivers. Opportunity to present some of the analyses from the Strategic Science Funds run-timing project, Chaput has summarized general run-timing patterns for adults in eastern Canada, Dempson looked at NFLD specific and annual variation, Mullins had looked at smolt run-timing)

3.2 Size, age, growth

3.2.1 Freshwater

- size of fry, age-1 parr, age-2 parr
- seasonal growth trajectories (Strothotte, et al. 2005; Randall and Paim 1982)
- size at age comparison across rivers (Saint John, Nashwaak, Big Salmon, Stewiacke, LaHave, St. Mary's, Margaree, West R. Sheet Harbour, East R. Sheet harbour, Philip, Buctouche, Miramichi, Tabusintac, Nepisiguit, Restigouche, Highlands, Harry's River, Humber(?), Western Arm, NFLD experimental rivers, various Quebec samples)
- comparisons within watersheds (tributary variations in Miramichi, Restigouche, Margaree; lacustrine versus fluvial juveniles in Newfoundland(?))
- inter-annual variation in size at age of juveniles (Swansburg et al. 2002)
- age and size at smoltification (general association between latitude and smolt age (Metcalfe and Thorpe 1990). Summarize age distributions from adult scales or smolt monitoring programs for Quebec rivers, (Porter et al. 1986), various Research Documents, data reports, analysis of existing databases Inter-annual variations in size at age of smoltification (how stable is it?)
- precocious maturation of parr (extent of occurrence, determinants, consequences, Myers et al. (1986) and Myers and Hutchings (1987) and recent studies in Quebec CIRSA)

3.2.2 Marine

- age at maturity (variations across rivers in relative abundance of 1SW, 2SW, 3SW – see Porter et al. (1986) for summary map example)
- size at age of 1SW, 2SW, 3SW, repeat spawners (various data reports, Research Documents, publications, databases), variation across rivers
- sex ratios at age (various data reports, Research Documents, publications, databases), variation across rivers
- repeat spawning (occurrence, relative change over time, expectations) (analysis of databases, various data reports, publications)

3.3 Fecundity and spawning

- size-fecundity relationships (variations among populations (Hutching and Jones 1998; O'Connell et al. 1997b; Randall 1989), databases, other publications)
- egg size
- relatively few eggs per spawning individual deposited in clusters at high densities

3.4 Natural mortality see review by Potter et al. (2003)

- juvenile survival rates (inter-stage relative survival rates, annual variations – Saint John, Nashwaak, Big Salmon, Stewiacke, LaHave, St. Mary's, Margaree, West R. Sheet Harbour, East R. Sheet Harbour, Philip, Buctouche, Miramichi, Tabusintac, Nepisiguit, Restigouche, Highlands, Harry's River, Humber(?), Western Arm, NFLD experimental rivers, various Quebec samples)
- egg to smolt survival rates – publications, research documents, databases, variation across rivers
- marine survival rates (return rate versus survival rate clarification)
  - direct measures of 'M' for 1SW stocks adjusted for 'F': Dempson et al. 2001
  - return rates for MSW stocks
  - changes over time, indicators using hatchery smolts (analyses in Potter et al. 2003.)

3.5 Population dynamics

- general fecundity and mortality tradeoffs for population replacement (Potter et al. 2003)
- stock and recruitment in Atlantic salmon (Walters and Korman 2001)
- density dependent and density independent factors regulating salmon abundance (Elliott 2001; Jonsson et al. 1998)

[*3. 5 Population modeling (***Gibson/ Amiro***) (background to elements of 1.6: see Chap 8)*
- *multiple indices for population estimation*
- *equilibrium models to assess management or recovery actions*
- *population viability analysis*

This is not the right place for this. It would be a better fit in Chapter 6]

3.6 Stock groupings (**Chaput**)

- using biological characteristics info from 3.1 (run-timing) 3.2 and 3.3, do dimension reduction analysis (PCA) followed by cluster analysis to see if logical (geographically) groups of rivers are defined or are there surprises? This would be useful when we need to consider stock groupings in the context of conservation units or metapopulations.

Chapter 4 Ecosystem attributes *(includes CSR [App. 1.] 1.3.1 Habitat requirements, CSR 1.4 Habitat requirements, 1.4.3 Physiology (e.g. depth, temperature requirements, 1.4.4 Dispersal/Migration, 1.4.5 Interspecific Interactions, 1.4.6 Adaptability)* (One author per Region)

4.1 Habitat requirements (CSR [App. 1.] number 1.3.1, 1.3.4 1.3.5, 1.3.6)

4.1.1 freshwater habitat **(Amiro)**

- physical habitat (including fluvial versus lacustrine versus estuarine rearing potential, substrate, velocities, sedimentation as factors modifying juvenile rearing, spawning, adult holding areas, over wintering and incubation habitat)
- water temperature constraints (adult and juvenile behaviour and survival)
- water chemistry and quality (pH, toxicity to heavy metals,...)
- constraints on freshwater migration (discharge, velocity limits,...)

4.1.2 marine habitat **(Reddin)**

- distribution in the marine environment (post-smolt, 1SW maturing, 1SW non-maturing)
- temperature preferences, temperature ranges, salinity ranges, constraints on distribution (e.g. due to sea ice)

4.1.3 Identification of Crucial Habitat (if possible at this point) **(Amiro/Gibson)**

4.1.4 Studies Required to Identify Crucial Habitat (if needed) (**Amiro/Gibson)**

4.1.5 Identification of Residence (where applicable) (**Amiro/Gibson**)

4.2 Salmon as predator (**Cairns)**

4.2.1 freshwater prey regimes

4.2.2 marine prey regimes

4.3 Salmon as prey (**Cairns**)

4.3.1 freshwater predation

4.3.2 marine predation

4.4 Interspecific interactions **(Cairns)**

4.4.1 freshwater competition

4.4.2 marine competition

Chapter 5 Atlantic salmon fisheries *(this appears out of step in the Table of Contents but it is difficult to talk about population sizes, trends, etc. ahead of descriptions of the fisheries data which are available for a longer period of time than any river-specific assessment data, and fisheries removed a large proportion of the returns of salmon. The landings data go back over a hundred years (or several hundred) and highlight variations in abundance and some have even indicated, cycles of abundance. This section would address some components of the socio-economic section in terms of commercial and recreational fisheries.)* (**Jones**)

5.1 Synopsis of historical catches by geographic area and overall

- commercial fisheries (home water, high seas)
- recreational fisheries
- Aboriginal fisheries (if relevant)

5.2 Fisheries landings as an index of abundance

Chapter 6 Reference levels and conservation requirements *(will cover a portion of CSR (App. 1) number 4. Potential Conservation Targets, and 4.1 Goal of Conservation Measures)* (**Chaput, Gibson**

6.1 Review of reference levels **(Chaput)** (limits vs targets) (Chaput 1997; Potter 2001 and Crozier et al. 2003

6.2 Conservation definition for Atlantic salmon (**Chaput**) (CAFSAC 1991ab)

- What is 2.4? (Chaput 1997; Chaput et al. 1998; Elson 1975; Symons 1979)
- Adjustments for lacustrine habitat (O'Connell and Dempson 1995; Chaput et al. 1998)
- Revisions by Quebec for MSY (Prévost et al. 2001; Caron et al. 1999)

6.3 Areas where conservation has not been defined (and why?) (**Chaput**): some southern Uplands rivers (due to acid rain impacts), Labrador (lack of habitat area and freshwater production data)

6.4 Use of reference levels in fisheries management **(Chaput)**

- management of home water fisheries (CAFSAC 1991ab)
- management of high seas mixed-stock fisheries, risk analysis (various ICES reports and Chaput et al. 2005)

6.5 Improvements to derivation and use of reference levels for population management **(Gibson)**

- moving away from management based on limits
- accounting for non-stationarity in recruitment dynamic (example: North America generally, LaHave River, Miramichi, Saint John, others? specifically)
- accounting for iteroparity
- equilibrium models to assess management or recovery actions
- population viability analysis

Chapter 7 Stock status *(CSR (App.1.) number 1.5 Population Size, Trends, and Uncertainty, with information on 1.5.1 Search Effort (data sources sought/considered) and focus on 1.5.2 Abundance, 1.5.3 Recent/historical Trends*
(including natural fluctuation), 1.6.1 Present/recent species trajectory, 1.6.2 Present/recent species status(?)
(4 regional inputs) e.g. Chaput (GU), Caron (PQ), Bourgeois/O'Connell(NFL) & Amiro/Gibson(MAR))

7.1 Data sources, spatial coverage, temporal coverage [summary of rivers assessed – update Excel file used by Chaput and Prévost (1999)]

7.2 Area specific measures of adult returns (by age or size group) in assessed rivers (use updated Excel file to summarize temporal and spatial trends in returns)
- temporal variations, trends
- contributions from enhancement programs (wild, hatchery, other)

7.3 Area specific measures of adult spawners (by age or size group) in assessed rivers (will require updating an existing file from ICES WGNAS(?))
- temporal variations, trends
- contributions from enhancement programs

7.4 Status relative to conservation (temporal variation and trends) (will require updating an existing file from ICES WGNAS(?))

7.5 Measures of freshwater production
- juvenile index trends (ICES file needs updating for 2004 – Chaput has the file)
- smolt production trends (file has been updated for 2004, Chaput has file)
- freshwater survival rate trends (juvenile inter-stage, egg to smolt,...) (see Chapter 3, is this a repeat? Could be done based on updated files)

7.6 Measures of marine production
- marine survival rate trends (smolt to adult return rates, adjusted for fishing) (ICES file has been updated for 2004, wild and hatchery – Chaput has the file. See Potter et al. (2003)
- broad measures of abundance by age group (ICES abundance trends for 1SW and 2SW)

7.7 Constraints on abundance
- issues to be brought forward from Chap 8, especially what is not a factor.

7.8 Status summary
is it possible to summarize status by area (perhaps as was done in Sydney for salmon rivers in eastern Canada (Chaput and Prévost 1999)? – need updated file from above.

(Chapter 8 Constraints on abundance *(this could touch on some points raised in CSR [App.1] 1.5.4, 1.6.3, 1.6.4, and 2.1* but now **Incorporated into 7.7.**
(Amiro/Gibson)

It would be useful to discuss some factors which we feel are not constraining abundance or recovery. For example most fisheries are severely curtailed or closed.

There are some factors which we know specifically are having an impact on abundance in some areas/rivers (fish passage issues on numerous rivers in which fishways are non-existent or don't function properly, low pH constraints on a number of southern Uplands rivers).

We could also include in this section or another, examples of stocks where intervention has resulted in an increase in abundance as expected (1984 management plan to increase spawners and the measured response from that intervention, at least for a few years) and examples where interventions have not resulted in the anticipated response (post 1992 moratorium, and lack of increased escapement or survival rates of smolts in some areas).

An example (or two) of recovery trajectories or modelling that Peter was referring to would also be useful for those cases of particular concern (Inner Bay of Fundy, Southern Upland?).

Title: Population Dynamics and Equilibrium, and population viability (Amiro/Gibson)
Model descriptions for

- Multiple indices to estimate population time series
- Population dynamics modeling and required parameters ,
- Equilibrium analysis
- Population viability distributions

Sample cases:

- high resolution cases e.g., Saint John, LaHave, Conne River, Western Arm Brook + others Trinité(?)
- using multiple index derived time series of populations e.g. Stewiacke and Big Salmon River
- lower resolution cases with minimum informed priors e.g. any river with only minimum indices e.g. recreational catch but belonging to a designatable unit with some known or accepted biological descriptions
- of a designatable unit with minimum indices and many informed priors e.g. Eastern SFA 19 lowland river and Eastern SFA 19 Highland river

Glossary

We use a large amount of terminology and a glossary is extremely important. There are examples in the Pacific Salmon Policy and in the SALMODEL report (EU Concerted Action).

References

CAFSAC, 1991a. Definition of conservation for Atlantic salmon. CAFAC Adv. Doc. 91/15 4p..

CAFSAC, 1991b. Quantification of conservation for Atlantic salmon. CAFAC Adv. Doc. 91/16 14p..

Caron, F., P.M. Fontaine, et S.E. Picard. 1999. Seuil de conservation et cible de gestion pour les rivières à saumon (*Salmo salar*) du Québec. Faune et Parcs Québec, Direction de la faune et des habitats. 48p.

Chaput, G.J. (Editor). 1997. Proceedings of a workshop to review conservation principles for Atlantic salmon in Eastern Canada. CSAS Proc. Series 97/15 33p.

Chaput, G., and E. Prévost. 1999. Annual and decadal change in Atlantic salmon (Salmo salar) abundance in eastern Canada. CSAS Res. Doc. 1999/030 45p.

Chaput, G., C.M. Legault, D.G. Reddin, F. Caron, and P.G. Amiro. 2005. Provision of catch advice taking account of non-stationarity in productivity of Atlantic salmon (*Salmo salar* L.) in the northwest Atlantic. ICES J. Mar. Sci. 62: 131-143.

Chaput, G., J. Allard, F. Caron, J.B. Dempson, C.C. Mullins, and M.F. O'Connell. 1998. River-specific target spawning requirements for Atlantic salmon (*Salmo salar*) based on a generalized smolt production model. Can. J. Fish. Aquat. Sci. 55 (Suppl. 1): 246-261.

Crozier, W.W., E.C.E. Potter, E. Prévost, P–J. Schon, and N.Ó Maoiléidigh. 2003. A co-ordinated approach towards the development of a scientific basis for management of wild Atlantic salmon in the north-east Atlantic (SALMODEL – Scientific Report Contract QLK5–1999–01546 to EU Concerted Action Quality of Life and Management of Living Resources). Queen's University of Belfast, Belfast. 431p.

Dempson, J.B., C.J. Schwarz, D.G. Reddin, M.F. O'Connell, C.C. Mullins, and C.E. Bourgeois. 2001. Estimation of marine exploitation rates on Atlantic salmon (*Salmo salar* L.) stocks in Newfoundland, Canada. ICES J. Mar. Sci. 58: 331-341.

Elliott, J.M. 2001. The relative role of density in the stock-recruitment relationship of salmonids. pp. 25-66 *In* Prévost, E., and G. Chaput [Editors.] Stock, recruitment and reference points: assessment and management of Atlantic salmon. INRA Editions 223p.

Elson, P.F. 1975. Atlantic salmon rivers smolt production and optimal spawning: an overview of natural production. Int. Atl. Salmon Found. Spec. Publ. Ser. 6: 96-119.

Hansen, L.P., and T.P. Quinn. 1998. The marine phase of the Atlantic salmon (*Salmo salar*) life cycle, with comparisons to Pacific salmon. Can. J. Fish. Aquat. Sci. 55 (Suppl. 1): 104-118.

Hutchings, J.A., and M.E.B. Jones. 1998. Life history variation and growth rate thresholds for maturity in Atlantic salmon, *Salmo salar*. Can. J. Fish. Aquat. Sci. 55 (Suppl. 1): 22-47.

Jonsson, N., B. Jonsson, and L.P. Hansen. 1998. Density-dependent and density-independent relationships in the life-cycle of Atlantic salmon, *Salmo salar*. J. Animal Ecol. 67: 751-762.

King, T.L., A.P. Spidle, M.S. Eackles, B.A. Lubinski, and W.B. Schill. 2000. Mitochondrial DNA diversity in North American and European Atlantic salmon with emphasis on the downeast rivers of Maine. J. Fish Biol. 57: 614-630.

King, T.L., S.T. Kalinowski, W.B. Schill, A.P. Spidle, and B.A. Lubinski. 2001. Population structure of Atlantic salmon *(Salmo salar* L.*)*: a range-wide perspective from microsatellite DNA variation. Molecular Ecol. 10: 807-821.

Mac Crimmon, H.R., and B.L. Gots. 1979. World distribution of Atlantic salmon, *Salmo salar*. J. Fish. Res. Board Canada. 36: 422-457.

McConnell, S.K., P.T. O'Reilly, L. Hamilton, J. Wright, and P. Bentzen. 1995. Polymorphic microsatellite loci from Atlantic salmon *(Salmo salar)*: genetic differentiation of North American and European populations. Can. J. Fish. Aquat. Sci. 52(9): 1863-1872.

McConnell, S.K., D.E. Ruzzante, P.T. O'Reilly, L. Hamilton, and J.M. Wright. 1997. Microsatellite loci reveal highly significant genetic differentiation among Atlantic salmon *(Salmo salar L.)* stocks from the east coast of Canada. Molecular Ecol. 6: 1785-1789.

Metcalfe, N.B., and J.E. Thorpe. 1990. Determinants of geographic variation in the age of seaward-migrating salmon, *Salmo salar*. J. Animal Ecol. 59: 135-145.

Myers, R.A., and J.A. Hutchings. 1987. Mating of anadromous Atlantic salmon parr, *Salmo salar* L., with mature male parr. J. Fish Biol. 31: 143-146.

Myers, R.A., J.A. Hutchings, and R.J. Gibson. 1986. Variation in male parr maturation within and among populations of Atlantic salmon. Can. J. Fish. Aquat. Sci. 43: 1242-1248.

O'Connell, M.F., and J.B. Dempson. 1995. Target spawning requirements for Atlantic salmon *Salmo salar* L. in Newfoundland rivers. Fish. Manage. Ecol. 2: 161-170.

O'Connell, M.F., D.G. Reddin, P.G. Amiro, F. Caron, T.L. Marshall, G. Chaput, C.C. Mullins, A. Locke, S.F. O'Neil, and D.K. Cairns. 1997a. Estimates of conservation spawner requirements for Atlantic salmon (*Salmo salar* L.) for Canada. CSAS Res. Doc. 1997/100 58p.

O'Connell, M.F., J.B. Dempson, and D.G. Reddin. 1997b. Inter-annual and inter-river variability in fecundity in Atlantic salmon (*Salmo salar* L.) in Newfoundland region rivers. CSAS Res. Doc. 97/94 33p.

Parrish, D.L., R.J. Behnke, S.R. Gephard, S.D. McCormick, and G.H. Reeves. 1998. Why aren't there more Atlantic salmon (*Salmo salar*)? Can. J. Fish. Aquat. Sci. 55 (Suppl. 1): 281-287.

Porter, T.R., M.C. Healey, M.F. O'Connell, E.T. Baum, A.T. Bielak, and Y. Côté. 1986. Implications of varying sea age at maturity of Atlantic salmon (*Salmo salar*) on yield to the fisheries. pp. 110-117 *In* Meerburg, D.J. [editor] Salmonid age at maturity. Can. Spec. Public. Fish. Aquat. Sci. 89. 118p.

Potter, T. 2001. Past and present use of reference points for Atlantic salmon. pp. 195-223 *In* Prévost, E. and G. Chaput [Editors]. Stock recruitment and reference points: assessment and management of Atlantic salmon. INRA Editions. 223p.

Potter E.C.E., N. O'Maoileideigh, and G. Chaput. 2003. Marine mortality of Atlantic salmon, *Salmo salar* L.: methods and measures. CSAS Res. Doc 2003/101.

Prévost, E., G.Chaput, and E.M.P. Chadwick. 2001. Transport of stock recruitment reference points for Atlantic salmon. pp. 95-135. *In* Prévost, E. and G. Chaput [Editors]. Stock recruitment and reference points: assessment and management of Atlantic salmon. INRA Editions. 223p.

Randall, R.G., and U. Paim. 1982. Growth, biomass and production of juvenile Atlantic salmon (*Salmo salar*) in two Miramichi River, New Brunswick, tributary streams. Can. J. Zool. 60: 1647-1659.

Randall, R.G. 1989. Effect of sea-age on the reproductive potential of Atlantic salmon (*Salmo salar*) in eastern Canada. Can. J. Fish. Aquat. Sci. 46: 2210-2218.

Strothotte, E., G.J. Chaput, and H. Rosenthalt. 2005. Seasonal growth of wild Atlantic salmon (*Salmo salar* L.) juveniles and implications on age at smoltification. J. Fish Biol. 67: 1585-1602.

Symons, P. 1979. Estimated escapement of Atlantic salmon (*Salmo salar*) for maximum smolt production in rivers of different productivity. J. Fish. Res. Bd. Canada. 36: 132-140.

Swansburg, E., G. Chaput, D. Moore, D. Caissie, and N. El-Jabi. 2002. Size variability of juvenile Atlantic salmon: links to environmental conditions. J. Fish Biol. 61: 661-683.

Utter, F., J.E. Seeb, and L.W. Seeb. 1993. Complementary uses of ecological and biochemical genetic data in identifying and conserving salmon populations. Fish. Res. 18: 59-76.

Verspoor, E., E.M. McCarthy, D. Knox, E.A. Bourke, and T.F. Cross. 1999. The phylogeography of European Atlantic salmon *(Salmo salar L.)* based on RFLP analysis of the ND1/16sRNA region of the mtDNA. Biol. J. Linnean Soc. 68: 129-146.

Verspoor, E., M. O'Sullivan, A.L. Arnold, D. Knox, and P.G. Amiro. 2002. Restricted matrilineal gene flow and regional differentiation among Atlantic salmon *(Salmo salar L.)* populations within the Bay of Fundy, Eastern Canada. Heredity 89: 465-472.

Walters, C., and J. Korman. 2001. Analysis of stock and recruitment data for deriving escapement reference points. pp. 67-94. *In* Prévost, E. and G. Chaput [Editors]. Stock recruitment and reference points: assessment and management of Atlantic salmon. INRA Editions 223p.

Document Development

This species was identified as a conservation concern through a previous Science peer-review. The species status report was developed by (name) and was reviewed on (date) in (place) (cite CSAS documents).

Drafting of this document was begun on (date) by (DFO or consultant) using existing jurisdictional information. A peer-review meeting was held (date) with representatives from affected jurisdictions, stakeholders (industry, NGOs) and Aboriginal Peoples, to gather further information and discussion. Proceedings of the RAP were published on (date). Comments were incorporated into the present document.

Contents of Conservation Status Report (CSR) — Part 1

Note: The following contains required content of

- COSEWIC status report
- Allowable Harm Assessment Framework
- SARA Recovery Strategy or Action Plan

1. Species Information

Summary introduction of species and rationale for conducting CSR for that species (i.e., rationale and basis for reviewing the conservation status of the species at this time)

1.1 Description of Species

1.1.1 Name and Classification
1.1.2 Morphological Description
1.1.3 Genetic Description
1.1.4 Ecologically Significant Units (if applicable)

1.2 Distribution

1.2.1 Global Range
1.2.2 Canadian Range

1.3 Habitat Considerations

1.3.1 Habitat Requirements
1.3.2 Habitat Trends
1.3.3 Habitat Protection/ Ownership
1.3.4 Identification of Crucial Habitat (if possible at this point)
1.3.5 Studies Required to Identify Crucial Habitat (if needed)
1.3.6 Identification of Residence (where applicable)

1.4 Biology

1.4.1 Life Cycle and Reproduction
1.4.2 Predation (identify main predators)
1.4.3 Physiology (e.g. depth, temperature requirements)
1.4.4 Dispersal/Migration
1.4.5 Inter-specific Interactions
1.4.6 Adaptability

1.5 Population Size, Trends, and Uncertainty

1.5.1 Search Effort (data sources sought/considered)
1.5.2 Abundance

1.5.3 Recent/historical Trends (including natural fluctuation)
1.5.4 Potential for Recovery (including recovery feasibility)
1.5.5 Rescue Effect

1.6 Scope for Harm
1.6.1 Present/recent species trajectory?
1.6.2 Present/recent species status?
1.6.3 Expected order of magnitude/target for recovery?
1.6.4 Expected general time frame for recovery to the target?
1.6.5 Is there scope for harm/mortality to the species that will not impede recovery?
1.6.6 What is the maximum harm/mortality that will not impede recovery?

2. Threats to the species
2.1 Limiting Factors and Threats (domestically and internationally)
2.1.1 List of threats (including real or potential mortality/harm)
2.1.2 Degree of harm from each threat
2.1.3 Aggregate total harm/mortality from threats and compare to allowable harm to determine what level of mitigation is needed

2.2 Assessment of Cross-Jurisdictional Authorities in relation to Threats

2.3 Early Identification of "Principal Stakeholders" in relation to Threats

3. Existing Protection
3.1 Legislation
3.2 Existing Status Designations (domestically and internationally)
3.3 Recovery Measures Currently In Place

4. Potential Conservation Targets
4.1 Goal of Conservation Measures
4.2 Proposed Species Rebuilding/Habitat Restoration Strategy
4.3 Recommended Actions/Recovery Schedule
4.4 Other Studies Needed

5. Significance of the Species
5.1 Scientific (endemicity, worldwide status...)
5.2 Ecological (top predator, significant prey item...)
5.3 Social/Cultural
5.4 Aboriginal
5.5 Economic

Implementation/Management Considerations

- Once the Conservation Status Report has been drafted, a socio-economic analysis of the contents of the assessment (e.g. proposed conservation targets) is initiated (in consultation with other jurisdictions as needed).

- A regional or national peer-review meeting (RAP/NAP) is planned and convened to review the assessment. This meeting includes clients, Sectors, First Nations, and jurisdictions.

APPENDIX 5

DRAFT AGENDA[1]
Workshop on conservation status of Atlantic salmon
Gulf Fisheries Center, Feb 13-17, 2006

Date/Time	F #	Authors	Topic	Reviewer
10:00AM Monday 13				
AM_1		Marshall	Welcome, goals, objectives, logistics	
AM_2	2ab	O'Reilly	Species description	Fleming
LUNCH				
PM_1	3	Caron	Distribution	Fleming
PM_2	11c	Chaput	GU stock status	Bradford
PM_3	11a	Dempson +	NFL stock status	Fleming
5:00 PM				
8:30AM Tuesday 14				
AM_1	4	O'Connell +	Biol. life history, groupings	Irvine
AM_2		***ALL***	***ESU/CU discussion/ SGrp?***	***All***
AM_3				
LUNCH				
PM_1	11b	Caron	PQ stock status	Irvine
PM_2	11e	Gibson +	Atlantic Canada stock status	Bradford
PM_3		***ALL***	***Stock status other approaches/ SGrp?***	***All***
5:00 PM				
8:30AM Wednesday 15				
AM_1		***SGrps(?)***	***Progress/ Questions***	***All***
AM_2	11d	Amiro +	MAR stock status	Bradford
AM_3	9	Jones	Fisheries	Fleming
LUNCH				
PM_1	5	Gibson	Population regulation	Bradford
PM_2	6a	Amiro	Freshwater habitat	Irvine
PM_3	6b	Gibson	Residence	Irvine
5:00 PM				
8:30AM Thursday 16				
AM_1		***SGrps(?)***	***Progress/ Questions***	***All***
AM_2	7	Reddin	Marine habitat	Bradford
AM_3	8	Cairns	predator/ prey	Irvine
LUNCH				
PM_1	12	Chaput	Rebuilding potential	Whoriskey
PM_2	10	Chaput	Reference levels	Bradford
PM_3	1	Marshall	Introduction	Fleming
5:00 PM				
8:30AM Friday 17				
AM_1		***SGrps(?)***	***Report***	
AM_2		***All***	***Proc abstracts/ wrap-up***	
10:30 AM				

[1] Due to storm delays/ flight cancellations the workshop did not commence until 2 PM Monday. With the exception of a group that formulated a framework and inclusions for a standardized compilation of sea-run Atlantic salmon rivers in Atlantic Canada/ Quebec, no subgroups were formed. A presentation and discussion on determining a 'recovery' target replaced 'Introduction' on late Thursday afternoon and drew closure to the entire workshop at 6:00PM.

APPENDIX 3

Attendees: Workshop on Conservation Status of Atlantic Salmon, Gulf Fisheries Centre, Moncton, NB - February 13-17, 2006.

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Fred Whoriskey	Atlantic Salmon Federation	St. Andrews NB	asfres@nbnet.nb.ca

APPENDIX 4

Working Papers presented at the Workshop with numbers assigned by the Canadian Science Advisory Secretariat (CSAS) for inclusion in the Research Document Series, October 2006.

Series	Number	Title_English	Authors
RES /	2006/ 012	Species description, Methods for developing CUs, review of genetics >>TITLE TO BE DETERMINED	O'Reilly, P.
RES /	2006/ 013	Distribution of salmon, number of rivers, river size. >>TITLE TO BE DETERMINED	Caron, F., G. Chaput, J.B. Dempson, A.J.F. Gibson, R.A. Jones
RES /	2006/ 014	Aspects of the Life History, Biology and Population Dynamics of Atlantic Salmon (Salmo salar) in Eastern Canada.	O'Connell, M.F., J.B. Dempson, G. Chaput
RES /	2006/ 015	A synthesis of life history characteristics and stock grouping of Atlantic salmon (Salmo salar L.) in eastern Canada.	Chaput, G., J.B. Dempson, F. Caron, R.A. Jones, A.J.F. Gibson
RES /	2006/ 016	Population regulation in Atlantic salmon (Salmo salar).	Gibson, A.J.F.
RES /	2006/ 017	A synthesis of fresh water habitat requirements for Atlantic salmon (Salmo salar).	Amiro, P.G.
RES /	2006/ 018	A synthesis of marine habitat of Atlantic salmon (Salmo salar).	Reddin, D.G.
RES /	2006/ 019	A review of predator-prey and competitive inter-specific interactions in Atlantic salmon (Salmo salar).	Cairns, D.K.
RES /	2006/ 020	Atlantic salmon (Salmo salar) fisheries and fisheries management in eastern Canada.	Jones, R.A., F. Caron, J.B. Dempson
RES /	2006/ 021	Reference levels and conservation requirements of Atlantic salmon (Salmo salar) in eastern Canada.	Chaput, G.
RES /	2006/ 022	Aperçu de l'état des stocks de Saumon atlantique (Salmo salar L.) dans les rivières du Québec, ZPS 1 à 11 ?>>>À CONFIRMER	Caron, F. et ??? >>>À CONFIRMER
RES /	2006/ 023	Stock Status of Atlantic Salmon (Salmo salar L.) from rivers of the Gulf Region, SFA 15 to 18.	Chaput, G., P. Cameron, D. Moore, D. Cairns, P. LeBlanc
RES /	2006/ 024	Atlantic Salmon (Salmo salar) overview for eastern Nova Scotia and inner Bay of Fundy (SFA 19 to 22) rivers.	Amiro, P.G., A.J.F. Gibson
RES /	2006/ 025	Assessments of Atlantic salmon stocks in southwest New Brunswick, an update to 2005.	Jones, R.A., L. Anderson, T. Goff
RES /	2006/ 026	National stock status overview trend analyses?? >>>TO BE CONFIRMED	Gibson, A.J.F., ?? Hubley, and G. Chaput >>>TO BE CONFIRMED
RES /	2006/ 027	Replacement ratios and rebuilding potential for two multi-sea-winter Atlantic salmon (Salmo salar L.) stocks of the Maritime provinces.	Chaput, G., R.A. Jones
RES/	2006/ 028	Stock status Summary of Atlantic salmon from Newfoundland and Labrador	Dempson, J.B., M.F. O'Connell, and D.G. Reddin